U.S. DEPARTMENT OF COMMERCE/ National Oceanic and Atmospheric Administration

OFCM

OFFICE OF THE FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

PROCEEDINGS OF THE FORUM ON URBAN METEOROLOGY

Meeting Weather Needs in the Urban Community

September 21-23, 2004
Doubletree Hotel and Executive Meeting Center
Rockville, Maryland (USA)

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March 2005

FOREWORD

The United Nations predicts that by 2025, 60 percent of the world's population will live in cities. In fact, at the present time, nearly two-thirds of the U.S. population lives in urban areas occupying less than two percent of the landmass, and as urban populations grow and become more concentrated, they become more vulnerable to severe weather, homeland security incidents, risks from air and water quality, and climatic variations. Urban decision makers responsible for safety and well-being of their cities are demanding predictions with greater specificity and greater accuracy. The time is right for advances in the area of urban meteorology because of greater concern over public health and safety; new urban focus on potential acts of terrorism; and technology advances and increased spatial and temporal resolution capabilities in remote sensing, observations, assimilation, modeling, and prediction. Communication of weather information has to be an end-to-end process which includes the complete weather and climate database and all results of applications (such as models, forecasts, advisories, and warnings), and supports a wide spectrum of users in all levels of government, industry partners, and the general public.

In response to these concerns the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM), in partnership with the Department of Homeland Security (DHS) Science and Technology Directorate, conducted a User Forum on Urban Meteorology September 21-23, 2004. The theme of the forum was *Information to Improve Community Responses to Urban Atmospheric Hazards, Weather Events, and Climate*. It focused on the following elements of urban meteorology: severe weather, homeland security, air quality, water quality, and climate. The forum's agenda included key presentations at the beginning and end of the forum, five plenary session panels, and six workshop sessions scheduled in pairs. The forum's objectives were to: reduce high impact weather and climate risks and improve the quality of life in urban areas; increase understanding and facilitate the transfer of emerging science and technology to meet today's urban weather and climate challenges; improve forecasting in coastal areas and areas with complex terrain; and set the stage for building user-tailored decision support systems for real-time response to the spectrum of hazardous weather events and atmospheric conditions.

This document summarizes the proceedings of the forum and provides a foundation for building on our successes. We are now developing clear guidelines and direction for establishing an interagency working group to address the actions that resulted from the forum. Activities will address the following crosscutting issues: regional ecosystems planning and management; public health and safety; urban observations; research and technology; urban modeling; information dissemination; education, outreach, and training; support for business continuity; and risk management and risk communication for time scales ranging from emergency preparedness (rapid response) and severe weather (intermediate time scales) to seasonal and generational climate fluctuations. I wish to thank the DHS Science and Technology Directorate and the more than 120 individuals from Federal, state, and local government, private industry, and academia, who were instrumental in making this forum a huge success.

Sincerely,

Samuel P. Williamson
Federal Coordinator for Meteorological
Services and Supporting Research

PROCEEDINGS

of the

Forum on
Urban Meteorology

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INTRODUCTION

Mr. Samuel P. Williamson
Federal Coordinator
Office of the Federal Coordinator for
Meteorological Services and Supporting Research

Welcome

After welcoming the participants to the Urban Meteorology Forum, Mr. Williamson acknowledged that the Department of Homeland Security Science and Technology Directorate partnered with OFCM in developing the Urban Meteorology Forum.

Following administrative remarks, Mr. Williamson stated that the theme of the forum was "Information to Improve Community Responses to Urban Atmospheric Hazards, Weather Events, and Climate." He also introduced the forum's five focus areas of meteorological information: severe weather, homeland security, air quality, climate, and water quality. He provided urban zone examples of property and lives lost as well as populations at risk within the context of these five focus areas.

Mr. Williamson next posed the question, "Why have an Urban Meteorology Forum now?" He stated that the need for such a forum is based on:

(1) Escalating demands/competition for urban resources.

(2) Advancements in science and technology which can substantially improve the accuracy and utility of weather and climate information in urban decision processes.

(3) An opportunity for better integration of multidisciplinary research to address urban weather and climate issues/concerns.

Mr. Williamson concluded his introduction by charging the Forum participants with:

(1) Identifying better ways to integrate, apply, and deliver weather and climate science and technology to urban decision makers and to reduce high impact weather and climate risk.

(2) Focusing on the relationship of natural hazards to urban ecosystems and their management and facilitating the transfer of emerging science and technology.

(3) Promoting close collaboration and integration of multidisciplinary research to address weather and climate impacts on urban communities and improving forecasting for coastal and complex terrain areas.

(4) Elevating the level of concern on priorities needed for funding research and application of science and technology on urban weather and climate problems/issues.

A complete summary of the Forum, as well as Mr. Williamson's remarks, can be found on the OFCM web site: www.ofcm.gov.

Dr. Kathie L. Olsen, Associate Director for Science
Office of Science and Technology Policy (OSTP)

Policy, Science, and Partnership Issues for the Complex Urban Environment

Dr. Olsen began her presentation by stating that by 2025, 60 percent of the world's population will live in cities. As a result, Dr. Olsen advised that:

(1) We need to understand hazards which could impact the urban zone.
(2) We need to be warned and know how to react.
(3) We need to be safe at home and at work.
(4) We need to recover quickly.

She next provided an overview of OSTP, noting that the office advises the President and the Offices of the President. Dr. Olsen also said that the OSTP leads the interagency effort to develop science and technology policies and budgets for all areas of science. Engaging in these activities requires OSTP to build strong partnerships among federal, state and local governments, other countries, industry, academia and scientific associations; develop clear, measurable goals and objectives for research and development programs; and assess Federal investments relative to the purposes of government.

Dr. Olsen articulated that the program decision process is both a top-down activity involving agency management, OSTP/OMB, and Congress and a bottom-up activity with input from academia, industry, etc. OSTP's program priorities are established using science priority criteria (e.g., science return, benefit to society, mandated program, partnership opportunity, technology readiness, program balance, cost/budget context, etc.) and implementation priority criteria. Using these criteria, Dr. Olsen shared with the Forum participants the FY 06 research and development priorities. These priorities include:

(1) Environment.

   (a) Climate change science & technology
   (b) Global observations
   (c) Water availability and quality
   (d) Hydrogen economy

(2) Biology of complex systems.

(3) Physical sciences.

(4) Research and development for Homeland Security.

(5) Networking and information technology.

(6) Nanotechnology

Dr. Olsen also gave an overview OSTP's components such as the National Science and Technology Council and the activities within the council's Committee on Environment and Natural Resources. Dr. Olsen concluded her presentation with a quote from Marshall McLuhan (1911 - 1980): "There are no passengers on spaceship earth. We are all crew."

A complete summary of the Forum, as well as Dr. Olsen's remarks, can be found on the OFCM web site: www.ofcm.gov.

Ms. Nancy Suski, Director
Department of Homeland Security
Emergency Preparedness and Response Portfolio, Science and Technology Directorate

Urban Meteorology for Homeland Security

Ms. Suski's presentation highlighted two areas:

(1) The broad spectrum of urban meteorology needs for Homeland Security and attendant requirements.

(2) On-going programs at the Department of Homeland Security.

With respect to urban meteorology needs for Homeland Security, Ms. Suski reminded the Forum participants that effectively simulating the environment requires an understanding of atmospheric phenomena that affect the transport, dispersion, and fate of threat agents in the atmosphere. Fast access to appropriate meteorological data, including archived, nowcast, and forecast data are required to adequately support these simulations. The data needs to be readily accessible and in a standard format that will allow access by multi-scale and diverse modeling systems. Ms. Suski also noted that the ability to provide early warning of atmospheric releases includes continuous 24/7/365 monitoring of urban areas (including critical facilities) as well as rapidly deployable, targeted monitoring of special events (such as national security special events, agricultural outbreaks, etc.). Support to these efforts involves characterizing the environment with the help of meteorological inputs.

Ms. Suski also highlighted the gaps in our understanding of the urban zone, which are relevant to Homeland Security. She stated that better and faster tools are needed to support incident characterization. She asserted that significant attention has been focused on prevention, interdiction, and providing an early warning that an atmospheric release has occurred. Less attention, however, has been focused on how incident characterization and response tools can be used to assess the extent of attack (e.g., the area contaminated and the people exposed). This type of information would provide decision makers with a better understanding of the scale of the event and provide tools so they can rapidly formulate and implement appropriate responses, including phasing of critical resources.

Ms. Suski turned her attention to the on-going research programs at the Department of Homeland Security. She articulated that "making our nation safer and more resilient to terrorist attacks is one of the key goals of the DHS research and development programs in atmospheric transport and dispersion." Two of the many programs which Ms. Suski highlighted included:

(1) The Interagency Modeling and Atmospheric Assessment Center – This center seeks to bring together the significant Federal capabilities for atmospheric hazard prediction for incidents of national significance. It will provide a single Federal hazards prediction to

be utilized by Federal, state, and local emergency responders, thereby eliminating confusing and conflicting hazard predictions.

(2) New York City Urban Dispersion Program – This program enhances New York City's emergency capabilities for addressing potential airborne releases of harmful materials. The program will advance understanding and characterization of the effects of urban processes on atmospheric dispersion in large cities, leading to improved and validated urban parameterizations for atmospheric dispersion models. It will also couple indoor and outdoor studies to further understanding and characterization of outdoor-indoor exchange.

Ms. Suski concluded her remarks by recognizing that meeting urban meteorology needs and the goals of the aforementioned programs will require a combined effort across many different agencies and at all levels of government.

A complete summary of the Forum, as well as Ms. Suski's remarks, can be found on the OFCM web site: www.ofcm.gov.

Mr. Eric Webster, Majority Staff Director
U.S. House of Representatives
Science Subcommittee on Environment, Technology and Standards

A Congressional Perspective on Urban Meteorology

Mr. Webster's stated that urban meteorology is a "confusing concept." He advised the Forum participants that laying out clear and attainable goals is important. He also noted that "Federal funding can be difficult." Playing the role of devil's advocate, Mr. Webster asserted that the goal of focusing on urban meteorology is to "save lives, help people, etc." Using that thesis, he argued that there are anecdotes about technology providing more and better information which will save lives, "but 35,000 people died in Europe last summer because they didn't have fans or air conditioning. Does it matter if we can predict the temperature more accurately by one or two degrees? The real issue is getting people fans, AC and the information they need to stay alive. We must look at the cost/benefit analysis – fans, AC – lives saved vs. technology, etc."

He also provided road weather research as another example of a cost/benefit analysis. He stated that road weather research saves lives through better weather information, mesoscale networks, road sensors, etc. Noting that researchers wanted tens of millions of dollars, he asked what are the real causes of deaths on the highways? He questioned whether it would be better to spend "a couple of million and have AMS work with AAA to teach teenagers/others how to drive in wet or snowy conditions." He also acknowledged that the Science Committee put in the provision to create a road weather research program. He ended this example by saying that "we are not against the research, [we] just want to put all of this in perspective."

Mr. Webster also articulated the need for a consistent message. Using plume modeling as an example, he stated that Congress get[s] mixed messages from agencies. He noted that "one week DOE tells us they do it. [The] next week it is DOD, then NOAA and now DHS." As an alternative he suggested that "what would make a real difference, is the whole system, program, research organized rationally, etc."

Mr. Webster then shifted to the work Congress is doing on NOAA's Organic Act legislation – legislation that would define the basic mission and functions of NOAA. Within that legislation, Mr. Webster wants to ensure that NOAA's research is better coordinated and that it eliminates "some of the stove pipe mentality in NOAA."

Mr. Webster concluded his remarks by exhorting the Forum participants to "develop a good, responsible, cost-effective plan."

A complete summary of the Forum can be found on the OFCM web site: www.ofcm.gov.

Dr. Ronald D. McPherson, Executive Director Emeritus
American Meteorological Society

Perspectives on the Interdisciplinary Scope and Approaches to Urban Meteorology

Dr. McPherson asserted that "We have to learn to communicate effectively among scientific disciplines, applications disciplines, and the lay public." With this charge in mind, the thrust of his remarks centered on four themes:

(1) Communication and the historical development of meteorology.

(2) Scientific disciplinary linkages in the urban zone.

(3) Applications disciplinary linkages in the urban zone.

(4) AMS contributions to enhanced interdisciplinary communications.

Dr. McPherson acknowledged that historically meteorologists communicate "fairly well communicating with each other, but with one major exception not so well when talking to persons in other scientific disciplines, or in the applications disciplines, or to members of the general public." He noted that there were so many first-order problems associated with the meteorological discipline that most linkages with other earth science disciplines were regarded as second-order or greater. These linkages were in many cases known or suspected, but were rarely explored or exploited.

He noted, however, the progress toward an interdisciplinary approach. He stated that "the problem of weather forecasting is certainly not solved, but very great progress has been made in the last few decades, and as a result increasing attention has been directed to the interaction of meteorology with other disciplines." He highlighted such examples as the flow of air over and through building, the contrasts of temperature due to differing responses to solar radiation and urban heat sources, and the introduction of pollutants to air and water as illustrating the complexity that involves meteorology, hydrology, atmospheric chemistry, and in coastal areas, air-sea interaction. These disciplines in turn interact with other scientific disciplines, such as physiology, ecology, and medicine Although in general meteorologists are beginning to reach out to other scientific disciplines, he noted the exception of professional meteorologist on television who "have done much over the last 50 years to familiarize the public with the tools and trade of modern meteorology … Television meteorologists are therefore an important asset in urban meteorology, and can be even more important in the interdisciplinary approach to communications between scientific disciplines, applications disciplines, and the public."

Dr. McPherson stated that scientific disciplines affect such decision makers as political leaders, law enforcement, emergency managers, business leaders, traffic managers, health care professionals, and utilities (e.g., water, sewer, energy, and communications) managers. However, he noted that these decision makers do not want to act as meteorologists. They prefer to receive meteorological advice which is relevant and in a

useful form. Thus Dr. McPherson asserted that the fact "that meteorologists do not wish to be, for example, traffic managers, and traffic managers do not wish to be meteorologists, is a major interdisciplinary communications problem for which a solution must be developed."

The AMS established a Board on the Urban Environment. It is deliberately interdisciplinary and responsible for organizing scientific conferences and workshops designed to focus attention on the urban environment, drawing together the various scientific disciplines engaged in the urban zone.

Lastly, Dr. McPherson shared his thoughts on the road ahead. In January 2005, the AMS will introduce a new program, the Certified Broadcast Meteorologist (CBM) program, to raise the standards [of broadcast meteorologists] even higher, and to encourage those who hold the CBM designation to equip themselves to cover a broader range of environmental issues. He asserted that "the CBMs will be a major asset for enhanced communications among the players in the urban environment."

A complete summary of the Forum, as well as Dr. McPherson's remarks, can be found on the OFCM web site: www.ofcm.com.

Dr. Gilbert Brunet, Associate Director
Environment Canada
Meteorological Research, Meteorological Services of Canada

The Regional and Urban Numerical Weather Prediction and Operational Long Range Plan for the Meteorological Service of Canada

Dr. Brunet's presentation emphasized four areas:

(1) A description of the Canadian Meteorological Centre and Meteorological Research Branch.

(2) Multi-scale meteorological modeling.

(3) NWP now, in one year, and ten years.

(4) Future research and development challenges.

Dr. Brunet stated that the Canadian Meteorological Centre and Meteorological Research Branch are the Canadian equivalent to NOAA/ NWS/ NCEP and the Navy's FNMOC for NWP and equivalent to Lawrence Livermore National Laboratory's National Atmospheric Release Advisory Center for multi-scale atmospheric transport and dispersion modeling. He next gave examples of multi-scale meteorological modeling endeavors. These examples included improvements to hurricane forecasting (e.g., full life-cycle modeling), precipitation rates on a global scale, and representation of urban surfaces.

Dr. Brunet highlighted modeling opportunities within the urban zone. He noted that in the higher resolution convective scale models which are on the verge of being operationally implemented at the Canadian Meteorological Centre, it will become increasingly important to correctly represent physical processes over urban surfaces. For example, in the case of the short- and medium-range weather forecast systems currently operational at the Centre, even large urban areas (e.g., 50 km x 25 km) have a negligible impact on the atmospheric circulations produced by the models. To remedy this situation, Dr. Brunet recommends that high-resolution topography as well as physics parameterization (e.g., town energy budgets) be incorporated into models. Dr. Brunet also noted that due to Canadian/Japanese collaboration a computer system which is 25 times more powerful than the IBM cluster currently used at the Centre's Earth Simulator Center will be available in the next 5 to 10 years. These new systems will be a factor in enhancing the Centre's urban zone predictive capabilities.

With respect to future research and development challenges, Dr. Brunet stated that for Calendar Years 2004-2005 the research and development strategy in collaboration with the Centre, regional weather services, and Canadian universities will include:

(1) Global NWP with a meso-global Global Environmental Multi-scale forecasting and modeling system (GEM) with a lid at the stratopause (.1mb) and with the regional GEM physics package.

(2) A four-dimensional variational analyses assimilation system with new asynoptic and satellite data.

(3) An Ensemble Prediction System (EPS) delivered with a comprehensive physics and initial condition perturbations approach. A comprehensive unified EPS Research and Development and Operational Long-range Plan has been initiated with the NWS. The "ribbon-tying" ceremony occurred 16-18 November, 2004, at NCEP in Camp Springs, MD.

A summary of the Forum, as well as Dr. Brunet's remarks, can be found on the OFCM web site: www.ofcm.gov.

Dr. Walter D. Bach, Jr., Program Manager
U.S. Army Research Office
Environmental Sciences Division, Engineering Sciences Directorate

Summary of the Report, "Federal Research and Development Needs and Priorities for Atmospheric Transport and Diffusion Modeling"

Dr. Bach stated that the purpose of the report was to present a research and development plan for providing the ATD modeling capabilities needed to meet established needs of the user communities, with special emphasis on enabling the National strategy for responding to domestic chemical, biological, radiological and nuclear incidents. The range of users included first responders, incident commanders, emergency managers, federal responders, emergency preparedness and response coordinators, as well as those concerned with military operations and air quality. Dr. Bach stated that from these users' perspectives, the desired information is "a workable answer [which is accurate] in the user's time frame."

Dr. Bach presented a schematic of a model for meeting the user's needs. Inputs to the model included observations, forecasts, and source terms (e.g., where, when, and how much). Outputs included health effects and environmental effects. While discussing the model, Dr. Bach touched on modeling uncertainty. He noted that the total model uncertainty is measured by the variance in the predicted and the observed quantity over a large number of events that have similar properties (an ensemble). Model uncertainty has three sources. The internal source consists of numerical approximations, modeling errors, and treatment of dynamical processes. Data errors in execution and evaluation, model parameterizations, and initial and boundary conditions make up the external contributions to model uncertainty. Lastly, the stochastic contribution to model uncertainty comes from the natural variability of the atmosphere.

Modeling and measurement research needs were the next topic in Dr. Bach's presentation. Among the needs which he articulated included:

(1) Bridging the gap from mesoscale to microscale models.

(2) Improving the characterization of surface boundary conditions in model parameterizations and in input data sets.

(3) Testing and refining the physical basis for sub-grid parameterizations.

(4) Developing methods and technologies for improving ensemble construction and implementation.

Dr. Bach concluded his presentation with a series of recommendations. The recommendations included, but were not limited to:

(1) Quantifying model uncertainties and interpreting their implications to users.
(2) Capturing and using existing data sets.

(3) Implementing ATD test beds.

(4) Improving the spatial and temporal scale interactions between meteorological and ATD models.

A complete summary of the Forum, as well as Dr. Bach's remarks, can be found on the OFCM web site: www.ofcm.gov.

Mr. Dave Jones, Founder, President and CEO
StormCenter Communications, Inc.
and President
Foundation for Earth Science

Raising the Environmental I.Q. of America through Innovative Agency and Media Partnerships

Mr. Jones began his presentation by articulating the goals of StormCenter (e.g., to apply environmental science in such a way as to engage Americans to increase their understanding of the environment, to utilize science information as a tool for improved public and agency decision making, and to increase public environmental awareness so better decision making can be made in times of crisis). He articulated that market research has found that weather "is the #1 reason people watch local news." Additionally, the research shows that people are in a learning mode when they watch the television weathercasts.

Mr. Jones also articulated the necessity and value of partnerships. He stated that most agencies have as part of their strategic plan a goal to communicate effectively with those whom they serve. Many agencies have valuable data sources but have not had a direct conduit to the public on a regular basis. Additionally, Mr. Jones asserted that excellent resources exist that should be tested for applications in media. As a result, StormCenter has established partnerships with such public and private organizations and institutions such as NASA, NOAA, Harvard University, the AMS, and National Aquarium in Baltimore.

The weathercasts and weathercasters of the future were also subjects of Mr. Jones's remarks. He stated that the television weathercasters are now looked upon as the station scientists. In that role, the weathercasters will address information on air and water quality (e.g., health risks), environmental hazards/pollution, toxic releases, forest fires, El Nino, climate change, urban meteorology issues, and more. He then presented images from television broadcasts to illustrate the range of environmental issues which weathercasters are now expected to bring forward to the viewing audience. He noted that the use of real-time information and imagery are critical to engaging and informing the public.

To further illustrate his point about the value of data, information, imagery, and partnership, Mr. Jones pointed to a number of StormCenter "firsts." For example, he provided to the Forum participants StormCenter's work with hurricane wind field modeling endeavors. This effort is based on the GFDL model which incorporates "land use [urbanization] into the model." Using this information, StormCenter developed a visualization of the official NHC forecast. This visualization provided storm path and intensity and was the "first time that the official NHC forecast was visualized as a high resolution wind field and delivered to media."

Mr. Jones ended his presentation, emphasizing that "by working together we can make a difference!"

A complete summary of the Forum, as well as Mr. Jones's remarks, can be found on the OFCM web site: www.ofcm.gov.

Dr. Richard D. Rosen, Assistant Administrator
DOC/NOAA
Office of Oceanic and Atmospheric Research

Research and Development to Meet Urban Weather and Climate Needs

Dr. Rosen's remarks addressed the question, "Why urban meteorology now?" He stated that the three overarching reasons for addressing meteorological aspects of the urban zone are:

(1) Technological advances.

(2) Homeland Security.

(3) Health and Safety.

With regard to technological advances, Dr. Rosen stated that NOAA is working toward an integrated observing system to take into account a myriad of observational data (e.g., satellite data, UrbaNet, private sector "Weather Nets", and buoys) and to optimize their use. He then provided examples of how technological advances in observing systems allow atmospheric scientists to discern conditions which impact the urban zone. For example, we can now detect with enhanced clarity dust and air pollution flowing from China and destined to reach the U.S. The UrbaNet site located atop the U.S. Commerce Department headquarters building in Washington, D.C. collects three-dimensional wind vector, temperature, pressure, relative humidity, and solar radiation data in 1-minute intervals and transfers summaries of those data every 15 minutes. He noted that the UrbaNet data are particularly valuable for dispersion applications.

With regard to Homeland Security, NOAA's Air Resource Laboratory is partnering with EPA in Research Triangle, NC to model lower Manhattan. The Hybrid Single Particle Legrangian Trajectory model is used to characterize plumes and predict trajectory end points at hour intervals. At small scales UrbaNet data are assimilated into this model and "can have significant impact" on the model's predictive capability, a capability which will support a system to orderly evacuate cities during hazardous events.

Dr. Rosen explained that NOAA's involvement in the Air Quality Program addresses health and safety issues. One of the program's objectives is to provide scientific advice for decision makers. For example, regional assessments will discover key atmospheric processes that contribute to poor air quality such as Houston, TX's refinery emissions and New England's nocturnal chemistry. The air quality forecasting component of the program has implemented an operational ozone forecast. "A broader range of significant pollutants" will follow. Dr. Rosen also noted that urban areas are especially vulnerable to high impact weather, because of the concentration of lives and property. Severe thunderstorms and tornadoes affect trees, power lines, and buildings. Heat waves are the direct cause of more deaths than all other weather conditions combined. Additionally,

winter weather impacts transportation and utility infrastructure. As a result, Dr. Rosen concluded that:

(1) The need for an urban focus was magnified by 9/11 attacks, but longstanding issues regarding health and safety continue to demand attention.

(2) New observing systems and improved models point the way forward for research.

(3) The complexity of urban meteorology issues demands that NOAA partner with the broader community to advance research and development.

A complete summary of the Forum, as well as Dr. Rosen's remarks, can be found on the OFCM web site: www.ofcm.gov.

Ms. Chris Elfring, Director
The National Academy of Sciences
Board on Atmospheric Sciences and Climate

Challenges in Making Weather and Climate Information Useful in Decision Making

Ms. Elfring began her presentation by providing the Forum participants with background on the National Academies and the Board on Atmospheric Sciences and Climate. She stated that the purpose of the National Academies is to serve as advisors to the Nation on science, engineering, and medicine. The role of the Board seeks to advance understanding of the atmospheric sciences, meteorology, and climate; foster application of this knowledge to benefit the public; and advise U.S. research programs so they are responsive to scientific opportunities and the needs of the nation.

Turning her attention to urban meteorology, Ms. Elfring stated that there are a number of reasons for focusing on urban meteorology. For example, there is "clear evidence of human and economic impacts" on the urban zone. Additionally, advances in science and technology now can support improved capabilities and improved integration of information. She also articulated urban meteorology's underlying needs to include:

(1) The need to understand the hazards and potential impacts within the urban zone.

(2) The need to be warned and know how to react appropriately.

(3) The need to be able to be safe during and after hazards.

(4) The need to be able to recover quickly (e.g., infrastructure, health, and cascading problems).

Ms. Elfring also noted that the challenges articulated by the keynote Forum speakers fell into two categories – research (e.g., "things we need to understand better") and usefulness (e.g., "things we need to do better to increase the impact of what we know"). She gave examples of both. In incident modeling she said that the research challenge is to improve the ability to provide early warning of atmospheric releases (including tools to detect incidents and tools to model and characterize the extent and impacts of those incidents). The usefulness challenge is to improve "the way to integrate scientific capabilities from different providers and distribute [them] in an organized and consistent way to users (e.g., IMAAC)." Ms. Elfring also illustrated the research and usefulness challenges associated with urban observations. The research challenge is to gain better, high resolution data; measure numerous variables; and assure data quality and accessibility. The usefulness challenge is to determine how best to collect reliable data, allow easy processing by users, communicate in ways that meet user needs, and make training available.

Ms. Elfring identified other challenges for urban meteorology. She stated that we need to accept the importance of addressing real problems, "go for 'low hanging fruit'", and set

and attack priorities (with an eye to cost-effectiveness). Other challenges which she rendered included:

(1) Paying attention to moving from research to operations.

(2) Packaging information in ways that are truly useful to different users.

(3) Developing more creative approaches to partnerships among academic, private, and public sectors.

Ms. Elfring ended her presentation with the following question for the Forum participants' consideration: "How do you facilitate coordination, priority setting, and a realistic approach in a large, diverse scientific community?"

A complete summary of the Forum, as well as Ms. Elfring's remarks, can be found on the OFCM web site: www.ofcm.gov.

Mr. Robert Dumont, Senior Staff Meteorologist
Office of the Federal Coordinator for Meteorological Services and Supporting Research

Abbreviated Panel Summaries

Mr. Dumont presented the following summary information from each panel co-moderator:

Panel 1: Safety, Health, and Economic Impacts of Weather and Climate in the Urban Environment

(1) Lead times for tropical cyclones need to be increased and improved (lead times in general).

(2) We need to look at urban meteorology from a total system approach. By doing this we should be able to figure out a cost-benefit ratio showing which part or parts of the system provide the best benefit for unit cost increase.

(3) We need to educate urban meteorology decision makers on the information already available so we can get improvement in urban meteorology support now with little cost, and get urban meteorology on the "radar screen" of Congress and others as an important and successful area.

(4) To compare costs in life, injury, and property damage, we need to develop standard definitions of when a death, injury, or damage is truly linked to a weather event.

(5) We need to interface with stakeholders, define user needs and requirements for urban meteorology information, and then figure out who should provide it (public versus private debate).

(6) The public and private sectors need to work in partnership to improve the provision of real-time weather information to users.

Panel 2: Regional Ecosystem Approaches to Urban Environmental Hazard Management

(1) Collaboration is needed within disciplines and across disciplines. We need to identify focus areas and stakeholders. We need to define what ecosystems are and then agree on the definition of boundaries.

(2) We need an end-to-end system approach to ecosystem management that accounts for:

> (a) Complex physical processes that interact at multiple spatial and temporal scales, and balance many factors.
> (b) Variability in surface morphology/land cover both within urban areas and the surrounding region.

(c) Modification of both the urban area and its surrounding area. The assumption should not be made that urban climates will always be modified in the same way (e.g., urban areas are not always heat islands; some urban areas are cooler than the surrounding area).

(3) Implementation of the Ocean Commission Report recommendations will move the U.S. toward a regional approach. A regional ecosystem approach can address a range of considerations among complex, integrated, and interdependent systems/processes.

Panel 3: Adequacy of Urban Weather Observations

(1) Current observations are inadequate to meet the needs of the users.

(2) The spatial and temporal resolution must continue to improve and new emphasis must be placed on the vertical profile.

(3) We need to work on developing observation specifications for various users' needs: their accuracy, precision, and parameter averaging time requirements.

(4) Current outreach, education, and training are inadequate to meet the needs of urban observing system developers.

(5) Communications capabilities and other public accessible technologies, such as cell phones, must be considered.

(6) Urban integrated observing networks must be designed to meet the needs of the first responders, real-time analysis, and forecast models.

(7) Current coordination and collaboration processes are ineffective. Cultural and political obstacles may be greater than technological obstacles.

Panel 4: Research and Development for Urban Weather and Climate Applications

(1) We need a better understanding of urban influences on local weather.

(2) We need more realistic urban parameterization schemes in NWP modeling systems.

(3) We need detailed databases (e.g., urban characteristics, buildings, land use, population, etc.).

(4) We need to quantify the uncertainty in model products and interpret the uncertainty for users.

(5) Urban planners should be more involved with application development.

(6) Additional urban test beds and field studies are needed to promote better understanding of urban physical processes and model improvements.

(7) We need to collect and apply field study and test bed data sets to verification and validation of models.

(8) Appropriate visualization techniques should be developed in collaboration with end users.

Panel 5: Managing Risk in the Urban Environment

(1) We need new ideas for better protection of homes and businesses.

(2) We need a first responder data system that is user friendly and that can be activated and accessed quickly, with 1 km or less resolution and 15- to 30-minute updates.

(3) We need a model for changing wind conditions.

(4) Emergency managers need accurate and timely short- and long-term weather information.

(5) Users need to understand and test weather information tools at all levels of application.

(6) Wildfire responder needs include: common technology and tools, ground-based information, and responsible homeowners.

(7) Education, training, and outreach is needed throughout urban weather application activities.

(8) We need to develop regional-scale disaster risk atlases.

(9) It is prudent to retreat from coasts for long-term safety purposes.

(10) We need better technology transfer processes.

A summary of the Forum, as well as Mr. Dumont's remarks, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum
Panel 1 Summary

Panel Name: Safety, Health, and Economic Impacts of Weather and Climate in the Urban Environment

Panel Co-Moderators: (1) Mr. Raymond J. Ban, Executive Vice-President, The Weather Channel, Inc.; and (2) Dr. John A. Dutton, Professor Emeritus of Meteorology and Dean Emeritus College of Earth and Mineral Sciences, The Pennsylvania State University

Panelists: (1) Dr. John Hayes, DOC/NOAA/NWS; (2) Dr. Josephine Malilay, DHHS/CDC; (3) Mr. Richard Carbone, NCAR; and (4) Dr. Sharon Leduc, DOC/NOAA/NESDIS

Rapporteurs: (1) Ms. Mary M. Cairns, DOC/NOAA/OFCM; and (2) Mr. Frank Estis, OFCM/STC

Guiding Questions

The questions posed below for this panel were intended as guidance for focusing the panel discussion.

(1) What meteorological information needed by urban decision makers is not yet available? Why is it not available? For example, are there problems in getting it soon enough, problems in interpreting it for the decisions to be made, or problems of having the right kind of meteorological information (observations and/or forecasts)?

(2) How can we make better decisions about the value of having more or better meteorological information for managing the safety, health, and economic well-being of urban communities? What do we need to know to decide on the value of information? For example, do we need to agree on measured costs and benefits of having or not having specific meteorological information before we decide what information is useful and how to provide it?

(3) How can education, training, and outreach improve urban management and decision making with meteorological information? Can outreach to users aid in guiding R&D decisions and programs?

(4) What actions can we take now to improve policies or systems for providing meteorological information important to the health, safety, and economic well-being of urban communities?

Synopsis

Opening Remarks

Mr. Ban opened the session by setting the stage for the panel's discussion. He stated that there are unique impacts in and on the urban environment and they are important because of the

large concentrated population in urban environments. The challenges to health, safety, and the economy are directly related to these large populations. Therefore the payoff will be substantial if we solve these challenges.

Dr. John Dutton followed Mr. Ban and outlined how the meteorological community goes through the "waterfall of observations to reduction of adverse effects." He suggested there is a need to model the entire observation and forecast system, so we can optimize and demonstrate the cost versus benefit of developing more effective, high-value forecasts. That is, there is a need to quantitatively understand the impacts of the forecast.

Group Discussion

A wide-ranging discussion on "Safety, Health, and Economic Impacts of Weather and Climate in the Urban Environment" resulted in the following major findings or themes:

(1) More and better collaboration/coordination is needed among and between urban officials, emergency managers, and meteorology disciplines.

(2) Determining the benefit change with an improved forecast is important. Making this determination will lead to the best, maximum benefit per cost of forecast.

(3) Increased forecast lead times are needed.

(4) Education is a big key to improved urban meteorology information usage.

(5) There is a lack of standards when it comes to linking deaths to weather events.

(6) Discover user needs first. Then decide who should fill them.

(7) Use the customer's language to express risk, options, and recommendations.

(8) When will we link real-time observations and forecasts to users no matter where they may be located? For example cars have map screens, radios listing songs playing, etc. Where is weather in doing something like this?

Consensus Reached

The panel presentations and the attendant discussion resulted in the following areas of general agreement:

(1) Lead times for all severe weather events need to be increased and improved.

(2) Action should be taken to look at urban meteorology from a total system approach. By taking the total system approach, we should be able to figure out a cost-to-benefit ratio showing which part or parts of the system provide the best benefit for unit cost increase.

(3) We need to educate urban meteorology decision makers on the information already available so we can (a) get improvement in urban meteorology support now with little cost and (b) and get urban meteorology on the "radar screen" of Congress and others as an important and successful area.

(4) To be able to compare costs in life, injury, and property damage, we need to develop standard definitions of when a death, injury or damage is truly linked to a weather event.

(5) Collaborate with stakeholders to define user needs and requirements for urban meteorology information, and then figure out who should provide them (the public or private sector).

(6) While no one had an answer for linking real-time weather information to users, it was felt that the public and private sectors working together as partners will determine the link and respond to it.

Unresolved Issues

There were no issues articulated during the panel discussion that seemed to end without coming to a general consensus on how the community might move forward to solve the issues presented.

Recommendations

Action items/issues developed by the panelists are listed below.

There were no **short-term action items/issues** (those which can be addressed within the next year) identified by this panel.

The **medium-term action items/issues** (those which can be addressed in 4 years or less) included:

(1) Devise a system through which the urban meteorology community can aim at improvements with large benefit-to-cost ratios and consistently describe key needs to the nation and Congressional decision makers, so the highest priority education, operational services, dissemination technologies, research and development activities, etc. will be funded.

There were no **long-term action items/issues** (those which can be addressed in 4 – 10 years) identified by this panel.

A complete summary of the Forum, as well as the presentation of each panelist and co-moderator, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum
Panel 2 Summary

Panel Name: Regional Ecosystem Approaches to Urban Environmental Hazard Management

Panel Co-Moderators: (1) Dr. Douglas DeMaster, DOC/NOAA/NMFS; and (2) Dr. Laurence S. Kalkstein, Senior Research Fellow, Center for Climatic Research, University of Delaware

Panelists: (1) Mr. Leroy Spayd, DOC/NOAA/NWS Meteorological Services Division; (2) Mr. Allan Stahl, USDA/Natural Resource Conservation Service; (3) Mr. Charles B. Chestnut, U.S. Army Corps of Engineers (USACE)/Institute for Water Resources; and (4) Dr. Sue Grimmond, Indiana University/International Association for Urban Climate

Rapporteurs: (1) Mr. Jim McNitt, OFCM/STC; and (2) Lt Col Robert Rizza, DOD/USAF/OFCM

Guiding Questions

The questions posed below for this panel were intended as guidance for focusing the panel discussion.

(1) What urban management problems need an ecosystem approach? What is different about an ecosystem approach to these problems, and why is it better? What part does meteorological information play in understanding the problems and enabling an ecosystem approach to solving them?

(2) What are the limitations of currently available meteorological information for supporting ecosystem management approaches? What can be done to give the manager better information?

(3) What education, training, and outreach activities could improve understanding of ecosystem management approaches and the role of meteorological and atmospheric conditions, and climate in ecosystem impacts?

Synopsis

Opening Remarks

The problems/issues that were the impetus of the workshop and that were described in the co-moderators' opening remarks included:

(1) Communication and collaboration

(2) Ecosystem management

(3) Hazards mitigation and recovery actions

(4) Chain of events required for public to take action

Group Discussion

A wide-ranging discussion on "Regional Ecosystem Approaches to Urban Environmental Hazard Management" resulted in the following major findings:

(1) Collaboration and more effective communications among stakeholders are required. For example, there is a need to define what ecosystems are first, and then agree on the definition of boundaries.

(2) There needs to be an end-to-end system approach to ecosystem management that accounts for the:

(a) Complex physical processes that interact at multiple spatial and temporal scales, and balance many factors.
(b) Variability in surface morphology/land use both within urban areas and within a region.
(c) Modification of both the urban area and its surrounding area. There should not be an assumption that urban climates will always be modified in the same way (e.g., urban areas are not always heat islands; some urban areas are cooler than the surrounding area).

(3) Implementation of the U.S. Ocean Commission recommendations will move the U.S. toward a regional approach. A regional ecosystem approach can address a range of considerations among complex, integrated, and interdependent systems/processes.

Consensus Reached

The panel presentations and the attendant discussion resulted in the following areas of general agreement:

(1) Collaboration is needed within disciplines and across disciplines.

(2) There is a need to identify focus areas and stakeholders.

(3) There is a need to coordinate across both horizontal and vertical lines of communication.

Unresolved Issues

Issues that were articulated during the panel session but were not pursued further, due to time constraints, included:

(1) Field experiments and test beds.

Recommendations

Several key action items/issues were developed by the panelists.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Identify stakeholders and define "ecosystem" as it pertains to this effort.

(2) Increase opportunities for collaboration among all communities working in hazards mitigation.

(3) Increase education and outreach efforts (build on the Chesapeake Bay example).

The **medium-term action items/issues** (those which can be addressed in 4 years or less) included:

(1) Generate a National effort to collect and manage land use data.

(2) Build upon existing studies (e.g., Baltimore, MD and Phoenix, AZ). Implement long-term test beds.

The **long-term action items/issues** (those which can be addressed in 4 – 10 years) included:

(1) Explore an expanded role for universities, including formal education tracts for urban ecosystem managers.

A complete summary of the Forum, as well as the presentation of each panelist and co-moderator, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum
Panel 3 Summary

Panel Name: Adequacy of Urban Weather Observations

Panel Co-Moderators: (1) Dr. Ken Crawford, Oklahoma State Climatologist; and (2) Dr. Rayford P. Hosker, Jr., DOC/NOAA/OAR

Panelists: (1) Dr Walter Dabberdt, Vaisala, (2) Mr. Richard Fry, DOD/DTRA; (3) Dr. Jan Dutton, AWS Weather Bug, and (4) Dr. John McGinley, DOC/NOAA/OAR

Rapporteurs: (1) Mr. Donald Carver, OFCM/DOT; and (2) Mr. Tony Ramirez, OFCM/STC

Guiding Questions

The questions posed below for this panel were intended as guidance for focusing the panel discussion.

(1) What are the requirements for timeliness, accuracy, and precision for urban applications of meteorological information (public health and safety; business and community planning and management; emergency planning, response, and recovery; transportation systems management; and power and communications vulnerability to solar eruptions)? Do current observing systems meet these requirements?

(2) Where current observing systems do not meet urban requirements; of these, which needs have the highest priority?

(3) What are the major challenges in collecting, processing, assimilating and communicating urban weather observations to meet urban users' requirements?

(4) Are the education, training and outreach challenges related to weather observations being addressed?

Synopsis

Opening Remarks

Dr. Hosker opened the session by emphasizing that the collection and dissemination of weather data in urban areas face unique challenges. Among these challenges are complexities of terrain. He pointed out that science issues such as the inadequate resolution of spatial scales and the representativeness of observations continue to be major concerns. Non-science issues such as funding for measurement networks and problems in siting sensors continue to constrain improvement efforts. He outlined the needs for improvement in urban weather observations and related these needs to each of the forum's five focus areas: (1) the need for more observations to detect and monitor severe weather; (2) special integrated networks, vertical data, and coupling

for homeland security; (3) enhanced networks and vertical sensors for air quality data; (4) the use of radar observations to supplement precipitation measurements for water quality data; (5) the need for a firm commitment to quality observations in monitoring climate changes.

Dr. Crawford presented an opening perspective based on his experiences with the Oklahoma Mesonet. He stressed that timeliness, such as the collection of short-term average intervals, and the accuracy of all measured parameters are important areas that must continue to improve. He further related that the proper siting of urban networks is the most critical issue in design and implementation. He went on to say that when dealing with collecting, processing, assimilating, and communicating data and products, we must be sure to be responsive to the needs of the users, particularly first responders. Dr. Crawford went on to point out that there aren't enough formal education and training programs to meet the needs of urban users.

Discussion

A wide-ranging discussion on "Adequacy of Urban Weather Observations" resulted in the following major findings:

(1) There is a lack of funding for urban observing network programs.

(2) The challenges and criticality in properly siting observing networks needs to be addressed

(3) There is a need for improved accuracy and precision in the data.

(4) Quality assurance as well as the resolution of data and products needs to be addressed.

(5) There is a lack of availability of data in the public domain.

(6) Outreach, education, and training programs for both users and providers are significant shortfalls.

(7) The process for the design of urban observing networks should include the use of test beds. These test beds should also be routinely used to assist in the efficient transition of the research to operations.

(8) Public, private, and academic partnerships are an effective means for improving collaboration and cooperation in research and development among all stakeholders, particularly with regard to funding and cost sharing opportunities.

(9) Vertical resolution of weather parameters and data in urban and surrounding areas are needed for both users and providers. Doppler radars, lidars, and wind profilers are currently being used to address vertical resolution and the specific needs of atmospheric transport and diffusion modelers.

Two specific capabilities were also briefed to the group during this session: (1) the data capabilities of the AWS Weatherbug and (2) the ongoing microscale meteorological measurements conducted at the space centers.

Consensus Reached

The panel presentations and the attendant discussion resulted in the following areas of general agreement:

(1) Meteorological observations of today are inadequate to meet the growing and diverse needs of the users and providers of weather information in the urban environment. The siting of observational sensors is possibly the most critical step in the design and implementation of urban networks. Poor siting will inevitably result in unrepresentative data and therefore degraded information and products for the users. These data and informational products must meet the needs of on-site users and the models. The measurement networks must measure both the boundary layer flow and the more turbulent flow within elements of the urban environment.

(2) The spatial and temporal resolution of observations must continue to improve, and new emphasis must be placed on the collection of data in the vertical.

(3) Much work is needed on understanding and developing specifications for various users' observations needs in terms of accuracy thresholds, precision thresholds, and collection of short-term averages in smaller time intervals.

(4) Current outreach, education and training programs are either not available or inadequate to meet the needs of urban observing system developers. Specifically, there is not enough training available in the growing field of urban observing system engineering. It is also important that the developers of these new systems respond to the specific needs of urban users.

(5) Communications capabilities other than publicly accessible technologies such as cell phones must be considered when developing information receipt and dissemination strategies. Under crisis situations, the cell system, for example, will likely become saturated, thereby interrupting the transmission and receipt of critical data.

(6) Urban integrated observing networks must be designed to meet the needs of the first responders. In this regard, first responders have a critical reliance on the real-time analysis of current weather parameters and the output of the forecast models.

(7) Current coordination and collaboration processes among members of the Urban Meteorological user and provider communities are either ineffective or non-existent. In addition, public/private/academic partnerships are weak. Cultural obstacles may be greater than technological obstacles.

Recommendations

Several key action items/issues were developed by the panelists.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Develop more effective partnerships within public/private/academia sectors.

(2) Develop methods to design urban observing networks and guide instrumentation siting.

(3) Develop test-beds with user input to assist in design and the transition of research to operations.

(4) Conduct urban experiments on existing networks and consider the following:

(a) Merging to GIS databases.
(b) Analyzing results to adjust measurements siting.
(c) Developing and implementing tailored products for users.

The **medium-long term action items/issues** (those which can be addressed in 4 years to 10 years) included:

(1) Develop and implement outreach, education, and training programs to meet the needs of urban observing system engineers and users.

(2) Collect short-term averages at intervals less than 5 minutes by 2010, and 1- to 2-minute interval observations after 2010 to be made available to the public within 1 or 2 minutes of collection.

(3) Bring current Doppler radar and Doppler lidar technologies to operational use for atmospheric transport and diffusion and other applications.

(4) Develop reliable communication technologies for data acquisition and dissemination.

(5) Set up experimental networks for one or more urban areas.

(6) Deploy specifically designed network systems for certain unique urban areas.

There were no **long-term action items/issues** (those which can be addressed in 4 – 10 years) identified by this panel.

A complete summary of the Forum, as well as the presentation of each panelist and co-moderator, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum
Panel 4 Summary

Panel Name: Research and Development for Urban Weather and Climate Applications

Panel Co-Moderators: (1) Dr. Alexander MacDonald, DOC/NOAA/OAR; and (2) Dr. J. Marshall Shepherd, NASA/Goddard Space Flight Center

Panelists: (1) Dr. Robert Bornstein, San Jose State University; (2) Dr. Lloyd A Treinish, IBM, Thomas J. Watson Research Center; (3) Mr. John Pace, DOD/DTRA; and (4) Mr. David Williams, EPA/Office of Research and Development/Environmental Sciences Division

Rapporteurs: (1) CDR Stephanie Hamilton, DOD/DTRA; and (2) Mr. John Hannan, DTRA/NGC

Guiding Questions

The questions posed below for this panel were intended as guidance for focusing the panel discussion.

(1) What meteorological information is needed by—but not yet available to—urban decision makers which cannot be provided without research and development? What information needs could be better met through additional research and development? How long will it take to meet those needs?

(2) What current R&D activities have the greatest potential to improve the meteorological information useful to urban decision makers? How long will it take to produce the improvements?

(3) Based on the answers to questions 1 and 2, which R&D areas for meteorological information require more attention, higher priority, or more resources?

(4) Are there R&D results/products that are ready for transfer into urban applications now? Which needs for urban meteorological information will emerging R&D results address?

(5) How well are current R&D collaborations and partnerships working in meeting urban needs for meteorological information? Where are more collaboration and partnering needed or useful?

(6) Are the current R&D transfer processes effective in supporting urban applications? How could they be improved? Are existing test beds and other testing facilities adequate for transferring technology to urban applications?

Synopsis

Opening Remarks

The co-moderators welcomed the forum participants and in the interest of time moved immediately to presentations.

Group Discussion

A wide-ranging discussion on "Research and Development for Urban Weather and Climate Applications" resulted in the following major findings or themes:

(1) There is a need for automated notification systems that allow for the orderly evacuation of city populations.

(2) The deficiency of current urban parameterization schemes and databases needs to be addressed.

(3) Developing partnerships to utilize research knowledge, observations and applications is needed.

(4) End users are not sufficiently involved with science and technology development process.

(5) Sensor data fusion development is essential for addressing urban meteorology challenges.

(6) The increased use of remotely sensed meteorological data in numerical models is needed.

(7) Collaboration between federal and civil organization including more efficient transfer of technologies is needed.

Consensus Reached

The panel presentations and the attendant discussion resulted in the following areas of general agreement:
(1) There is a need for better understanding of urban influences on local weather

(2) More realistic urban parameterization schemes in numerical weather prediction modeling systems are needed.

(3) There is a need for detailed databases (e.g., urban characteristics, buildings, land use, population, etc.).

(4) Urban planners should be more involved with application development.

(5) Additional urban test beds and field studies are needed to promote better understanding of urban physical processes and subsequent model improvements.

(6) There is a need to collect and apply field study and test bed data sets to verification and validation of models

(7) Appropriate visualization techniques should be developed in collaboration with end users.

Unresolved Issues

There were no issues articulated during the panel discussion that seemed to end without coming to a general consensus on how the community might move forward to solve the issues presented.

Recommendations

Several key action items/issues were developed by the panelists.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Finish Landscan USA database development (EPA).

(2) Integrate advanced satellite and ground-based observations into numerical weather prediction systems (NASA).

The **medium-term action items/issues** (those which can be addressed in 4 years or less) included:

(1) Develop sensor systems and associated fusion techniques (DOD).

(2) Develop new geosynchronous perspectives on urban and dispersion issues (DOD, NASA, NOAA).

There were no **long-term action items/issues** (those which can be addressed in 4 – 10 years) identified by this panel.

A complete summary of the Forum, as well as the presentation of each panelist and co-moderator, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum

Panel 5 Summary

Panel Name: Managing Risk in the Urban Environment

Panel Co-Moderators: (1) Ms. Margaret Davidson, DOC/NOAA/NOS; and (2) Mr. Harvey Ryland, President and CEO, Institute for Business and Home Safety

Panelists: (1) Mr. Ranger Dorn, Battalion Chief, Ventura Co. Fire Department; (2) Mr. John Gambel, DHS/FEMA; and (3) Ms. Janet Anderson**,** USDA/ Forest Service/Fire and Aviation Management

Rapporteurs: (1) Mr. Floyd Hauth, OFCM/STC

Guiding Questions

The questions posed below for this panel were intended as guidance for focusing the panel discussion.

(1) In each of the forum's five focus areas, what are the hazards to which meteorological information applies? What information is needed to manage the risks from those hazards? Is the information available?

(2) What are the similarities and differences in information needed to manage risk by different categories of users, such as:

(a) Emergency response managers (including planners and responders)
(b) Business/enterprise managers
(c) Information media and other information providers?

(3) What education, training, and outreach activities should be part of risk communication and risk management in the five focus areas?

(4 What planning techniques or risk management practices have proven to be most useful in responding to hazards in the five focus areas, such as urban weather disasters or air and water quality hazards? What improvements in meteorological information would support these practices?

(5) Are we effectively transferring R&D results to applications to meet the needs of urban risk managers?

Synopsis

Opening Remarks

Mr. Harvey Ryland welcomed the co-moderator, Margaret Davidson, panel members, and the forum participants. He challenged the audience to come with "wild ideas" to help reduce risks for homes and businesses. He noted that such ideas were needed to help develop a new level of protection for homes and business. He provided examples of construction deficiencies and made a case for strong building codes and their enforcement to help make communities more disaster resistant. Mr. Ryland also noted the publication of a pamphlet entitled "How to Recover." This pamphlet provides guidance to the public.

Group Discussion

A wide-ranging discussion on "Managing Risk in the Urban Environment" resulted in the following major findings or themes:

(1) There is a need for a new level of protection for homes and businesses.

(2) There is a need for information (guidance) pamphlets useful for public.

(3) First responders and emergency managers do not have adequate tools/information.

(4) There are continued problems in managing risks (rebuilding in areas with repeated disasters).

(5) The big challenge is how to manage all the groups that have a stake in disaster response.

(6) Wildland fires are a challenging and growing problem (health effects, cost of losses increasing, forest fuels accumulating, urban/rural blending issues).

(7) Education, training and outreach is a problem across urban activities.

(8) Risk communication is a challenge. How do we get people to listen?

(9) Interaction with the media is very important.

(10) There are benefits to be gained with integrated planning.

(11) There are deficiencies in ways to transfer technology to users/operators.

(12) Consider the use of incentives and disincentives for disaster resistance actions is important.

(13) It is increasingly difficult to convince people to evacuate for hurricanes.

Consensus Reached

The panel presentations and the attendant discussion resulted in the following areas of general agreement:

(1) There is a need for new ideas for better protection of homes and businesses.

(2) A first responder data system that is user friendly, can be activated and accessed quickly, with 1 km or less resolution and 15 to 30 minute updates is essential to addressing the challenges of the urban environment.

(3) A model for changing wind conditions is needed.

(4) Emergency managers need accurate and timely short and long term weather information.

(5) Users need to understand and test weather information tools at all levels of application.

(6) Wildfire responder needs include (but are not limited to): common technology and tools, ground-based information, responsible homeowners.

(7) Education, training, and outreach are needed throughout urban weather application activities.

(8) There is a need to develop regional scale disaster risk atlases.

(9) It is prudent to retreat from coasts for long term safety purposes.

(10) There is a need for better technology transfer processes.

Unresolved Issues

There were no issues articulated during the panel discussion that seemed to end without coming to a general consensus on how the community might move forward to solve the issues presented.

Recommendations

Several key action items/issues were developed by the panelists.

The **short-term action items/issues** (those which can be addressed within the next year) with the office of primary responsibility identified by this panel included:

(1) Develop a user-friendly first responder data system that can be activated quickly, accessed and updated easily (NOAA, FEMA).

(2) Test and use appropriate decision support tools at all levels of emergence response (FEMA).

(3) Develop regional scale disaster risk atlases (FEMA, NOAA).

(4) Provide more training for diverse groups of first responders and emergency personnel.

(5) Develop accurate, timely and consistent data and promote the use of common technology and tools for wildland fire responders (NOAA, USDA).

The **medium-term action items/issues** (those which can be addressed in 4 years or less) with the office(s) of primary responsibility included:

(1) Develop a new level of protection for homes and businesses (IBHS, FEMA).

(2) Improve technology transfer processes for disaster applications (NOAA, FEMA).

There were no **long-term action items/issues** (those which can be addressed in 4 – 10 years) identified by this panel.

A complete summary of the Forum, as well as the presentation of each panelist and co-moderator, can be found on the OFCM web site: www.ofcm.gov.

Lt Col Robert Rizza
DOD/USAF
Office of the Federal Coordinator for Meteorological Services and Supporting Research

Abbreviated Workshop Summaries

Lt Col Robert Rizza presented the following summary information from each workshop cochair:

Workshop 1A: How to Improve the Content of Weather Observations to Meet Modeling and Operational Needs for Urban Areas

(1) More observations may be better but only if used/assimilated intelligently.

(2) Models need to be robust. They must be able to run at any time, 24/7.

(3) We need a skillful "data assimilation" system.

(4) We must understand true use before an observational network can be designed.

(5) Metadata is critical to making data useful.

Workshop 1B: Understanding the Needs of Urban Communities and Businesses

(1) More collaboration is needed.

(2) We could/should run economic models at the same time as we run meteorological models to clearly understand forecast impacts.

(3) We need to understand how people interpret what meteorologists say.

(4) Both public and private sector forecasters are affected by the knowledge and/or fear of possible law suits over less than perfect forecasts.

Workshop 2A: Measurement Strategies for the Urban Weather and Climate Domains (sensors, data collection, transmission, archiving, etc.)

(1) The strategy for cost-effective collection of measurement data for decision makers should focus on things that can be done now.

(2) A process is needed to determine the amount of data and the number of sensors needed to make decisions that minimize cost and characterize the unique complexity of terrain in every city.

(3) Users are not aware of and therefore are not using emergency decision-making information that is available today. Outreach, education, and training mechanisms are needed.

(4) A delivery system for providing layered GIS information to all public and commercial sectors is needed. Bringing this type of system into operations may require a change in federal policy.

(5) We must define a process on how to design a network on an urban scale and address particular decision-making applications (e.g., define questions for applications and interact with users).

Workshop 2B: Research and Development Needs for Ecosystem Approaches to Urban Health and Environmental Issues

(1) We need improved multi-scale observations in the urban environment with an emphasis on the vertical observation of the Planetary Boundary Layer.

(2) A national database management center that includes self-documenting metadata in standardized formats needs to be established.

(3) To manage within an ecological framework, we need to provide for the integration of all types of data (e.g., social, demographic, and economic).

(4) We need to be able to assimilate remotely sensed surface/building data and aerosol data into the models.

(5) We need to couple atmospheric transport and diffusion model outputs with consequence models addressing health, safety, and other impacts.

(6) We need to develop model verification and validation procedures based on user metrics.

(7) We need to enhance the interface with users. For example, we need to find out what users want, how they operate, and get their feedback during the product development/prototyping process.

Workshop 3A: Communicating Hazardous Weather Risks in the Urban Environment

(1) We need to standardize ways to communicate risk to the public and advise the public on what actions to take (e.g., terms, colors, probability forecasts, and graphics).

(2) Research is needed to determine the terms to use on a national level to communicate (e.g., work with public and social scientists to determine the best solution).

(3) The public is mobile. Therefore we need GIS/GPS-coded messages to advise the public of potential hazards regardless of the public's location.

Workshop 3B: Research and Development Resources to Address Deficiencies in Modeling for Urban Weather, ATD, Space Weather, and Climate Applications

(1) We need to collect, process, and synthesize data from existing field studies.

(2) We need to pull together and extend with additional parameters, urban data sets that are being developed by cities, government agencies, and others to develop, calibrate, and evaluate urban models.

(3) We need to establish standards and guidelines for databases, model output, and performance criteria.

(4) Research and development needs should be prioritized based on user needs.

(5) The transfer from research to operations should be user-based and include collaboration during all phases of the system life-cycle. Users should be included early and often. Recognition of the differences in user communities is needed.

(6) Collaboration needs to include leveraging of planned experiments, a clearinghouse for information, and better communications among user communities.

A summary of the Forum, as well as Lt Col Rizza's remarks, can be found on the OFCM website: www.ofcm.gov.

Urban Meteorology Forum
Workshop 1A Summary

Workshop Name: How to Improve the Content of Weather Observations to Meet Modeling and Operational Needs for Urban Areas

Workshop Cochairs: (1) Dr. Stephen Lord, DOC/NOAA/NWS; and (2) Col Mark Weadon, DOD/USAF/Air Force Weather Deputy for Federal Programs - NOAA

Rapporteurs: (1) Mr. Donald Carver, DOT/OFCM; and (2) Lt Col Robert Rizza, DOD/USAF/OFCM

Guiding Questions

The questions posed below for this workshop were intended as guidance for focusing the workshop discussion.

(1) What are the primary deficiencies in the content of weather observations for urban areas in relation to modeling and operational needs?

(2) What new sensors or other technologies are available or emerging that could improve the content of weather observations for urban areas?

(3) What kind(s) of R&D should receive emphasis to meet unaddressed deficiencies in weather observations for urban areas?

(4) Are new communication technologies sufficiently robust to accommodate current and future observation content, processing and dissemination for operational needs?

Synopsis

Opening Remarks

The workshop opened with a joint presentation from DTRA and AFWA. The presentation described DTRA and AFWA's efforts to support the summer Olympics. Data from standard WMO stations and the University of Athens mesonet was leveraged. Hazard Prediction and Assessment Capability was utilized via reach-back. The briefing served to stimulate discussion of the four guiding questions.

Group Discussion

A wide-ranging discussion on "How to Improve the Content of Weather Observations to Meet Modeling and Operational Needs for Urban Areas" resulted in the following major findings or themes:

(1) There is a need for standardized urban meteorology database.

(2) Detailed data on urban area/land use is an essential tool for decision makers.

(3) Comprehensive data quality control will be needed to address issues in the urban environment.

(4) The issue of model bias – weak or strong forcing function should be explored.

(5) An intelligent design of observational system/network is needed.

(6) A high-resolution turbulence parameterization is critical.

(7) Optical sensing using LIDAR technology should be considered as being applicable to the urban environment.

(8) A test bed strategy should be utilized to evaluate options.

(9) Defining/gathering metadata and archiving considerations is critical to addressing challenges in the urban environment.

(10) Sensing strategies (e.g., the DTRA/AFWA presentation about Athens Olympic support) can serve as "lessons learned."

(11) A national high resolution precipitation mosaic is a priority.

(12) Optimum sensor positioning: a ring of profilers around urban areas with an array of rooftop sensors is an essential tool for addressing environmental challenges in the urban environment.

(13) Resolution of data should not overwhelm the capacity of model to parameterize.

Consensus Reached

The workshop resulted in the following areas of general agreement:

(1) More observations may be better but only if used/assimilated intelligently.

(2) Models need to be robust. They must be able to run at any time (24/7), under all atmospheric conditions.

(3) There is a need for a "data assimilation" system and an accurate model for microscale applications to address such areas as:

(a) PBL physics & turbulence

(b) Accurate precipitation forecasts

(4) Understanding applications before observational network can be designed is a must.

(5) Metadata is critical to making data useful

Unresolved Issues

There were no issues articulated during this workshop that seemed to end without coming to a general consensus on how the community might move forward to solve the issues presented.

Recommendations

Several key action items/issues were developed by the workshop participants.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Investigate Oklahoma City mesonet data for use in urban meteorology sensing studies.

(2) Investigate any existing siting standards for urban observing systems.

The **medium-term action items/issues** (those which can be addressed in 4 years or less) included:

(1) Establish urban observation siting standards.

(2) Establish test beds to optimize sensor placement/assimilation.

The **long-term action items/issues** (those which can be addressed in 4 – 10 years) included:

(1) Support the New York City urban meteorology sensing model/system development.

A complete summary of the Forum, as well as available presentations from this workshop, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum
Workshop 1B Summary

Workshop Name: Understanding the Needs of Urban Communities and Businesses

Workshop Cochairs: (1) Mr. Floyd Hauth, OFCM/STC; and (2) Dr. Betty Hearn Morrow, Consultant and Professor Emeritus of Sociology, Florida International University

Rapporteurs: (1) Mr. Frank Estis, OFCM/STC; and (2) Mr. Rickey Petty, DOE/Climate Change Research Division

Guiding Questions

The questions posed below for this workshop were intended as guidance for focusing the workshop discussion.

(1) What do forecasters need to know about today's urban communities?

(2) How does the changing nature of urban communities affect their requirements for meteorological information?

(3) What information will best help urban businesses prepare for and respond to hazards in the five focus areas?

(4) What are the major deficiencies in meteorological information (including communication and interpretation of the information)? Which should receive priority in R&D or technology transfer?

(5) Are additional education, training, and outreach activities needed?

Opening Remarks

The workshop cochairs provided opening presentations to set the stage for the group discussion. Dr. Betty Hearn Morrow offered the following thoughts:

(1) Cities are:

(a) Where most people choose to live.
(b) Where some of the most vulnerable populations dwell.
(c) Vital to the national and world economy.

(2) Urban dwellers need to:

(a) Understand hazards.
(b) Be warned and know how to respond.
(c) Be safe at home and at work.
(d) Recover quickly.

(3) The responsibilities of the meteorological community include:

(a) Practicing good science.
(b) Working together to improve forecasts.
(c) Interpreting weather and climate information for urban managers and the general public.
(d) Communicating uncertainties and possible outcomes of low probability, high impact events.
(e) Helping the public make responsible choices.

(4) The deficiencies in meteorological information include:

(a) Inadequate knowledge of urban environment including populations.
(b) Problems with communicating uncertainty and risk.
(c) Limited coordination of efforts within the discipline.

(5) Obstacles and challenges are:

(a) A work culture characterized by:

- Interagency divisions, competitions.
- Private-public dichotomy.
- Introspection.

(b) Language challenges can be addressed by:

- Simplifying the message which is provided.
- Testing delivery and response.

(c) Outcome measurements which should be converted to societal impacts.

(6) More social science involvement which should include such activities as:

(a) Identifying stakeholder needs (e.g., stratified sample surveys of emergency managers and the general public).
(b) Testing messages and delivery systems (e.g., focus groups, simulations).
(c) Conducting post-event assessments (e.g., fieldwork, surveys).
(d) Understanding work culture (e.g., ethnographic studies of work environment).

Mr. Floyd Hauth provided the following opening remarks:

(1) Urban hazard mitigation factors include:

(a) Population density.
(b) Urban land use and building types.
(c) Transportation systems.
(d) Housing vs. urban poor.
(e) Storage of hazardous materials.
(f) Security risks posed by social issues.

(2) Hazard identification and vulnerability assessment encompass:

(a) Historical information.
(b) Shared experiences.
(c) An inventory of hazards.
(d) Impacts/consequences of hazards.
(e) Types of natural hazard information which includes:

- Incidence of hazard risks in the area of interest.
- Incidence of hazard risks in market areas and commercialization routes.
- Vulnerability of the supply and/or cost of production inputs (e.g., raw materials, equipment, energy resources) to natural hazard events.
- Vulnerability of the business output prices to natural hazard events.
- Vulnerability of physical structures and production processes to natural hazard events.
- Existence of current and/or proposed legislation that establishes guidelines for natural hazard risk mitigation in community or business design.
- Effectiveness and cost of alternative natural hazard mitigation measures.

(3) Strategic planning should incorporate:

(a) Building on known strengths and past successes.
(b) Information gathering.
(c) Communication.
(d) Partnerships and collaboration.
(e) Budgetary opportunities.
(f) Ownership.

(4) The components of an integrated methodology are:

(a) Performance criteria.
(b) Modeling economic system response.
(c) Evaluating economic aspects of mitigation strategies.

(5) Catalysts for urban strategy are (but not limited to):

(a) Public policies.
(b) Community action.
(c) Private sector commitment.
(d) Accountable local government
(e) Supportive national government

(6) The next steps for moving forward include:

(a) Gathering data.
(b) Identifying hazards.
(c) Assessing vulnerabilities.
(d) Categorizing and develop approaches to risks.
(e) Determining needs and priorities.
(f) Supporting multi-discipline research and applications.

Group Discussion

A wide-ranging discussion on "Understanding the Needs of Urban Communities and Businesses" resulted in the following major findings or themes:

(1) Most users of weather information now live in urban areas.

(2) Urban dwellers are more likely to be new to the area and to be renters.

(3) One in five households is headed by someone who speaks a foreign language.

(4) Most households now have computers and approximately 42% have internet connections.

(5) One in four businesses that close after a disaster never reopens.

(6) Weather messages need to be tested to see if they are understood.

(7) Ways to get people back to their homes more quickly after a disaster are needed. In some cases people don't evacuate due to fear of long-term separation from personal belongings and possible looting.

(8) A study of the uses of and an evaluation of the 5-day forecast including unexpected consequences (such as staging and storing emergency supplies, extra stress, etc) needs to be completed.

(9) The possible role of fear of law suits due to the weather forecasts and warnings issued by both public and private sectors may influence the work that these sectors perform.

(10) Identifying the types of natural hazard information needed by various sectors and users is needed.

(11) Broadcast media often feel "out of the loop" with NWS during events.

(12) There is a need for more collaboration with other disciplines such as social sciences as well as intra-discipline collaboration.

Consensus Reached

The workshop resulted in the following areas of general agreement:

(1) Urban users of weather information are very diverse.

(2) Today's forecast messages need to be tailored to diverse urban audiences.

(3) There is a need to better understand how different population groups interpret and use meteorological messages.

(4) More collaboration is needed.

(5) Economic models could/should be run at the same time as meteorological models are run to clearly understand forecast impacts.

Unresolved Issues

There were no issues articulated during this workshop that seemed to end without coming to a general consensus on how the community might move forward to solve the issues presented.

Recommendations

Several key action items/issues were developed by the workshop participants.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Involve more social science in such activities as: identifying stakeholder needs (stratified sample surveys of managers and general public); testing messages and delivery systems (focus groups, simulations); post-event assessments (fieldwork, surveys); and understanding work culture (ethnographic studies of work environment).

(2) Investigate possible changes to the use of the terms "watch" and "warning" to develop an improved public warning notification system.

(3) Evaluate the effects of 5-day forecasts.

(4) Investigate how broadcast meteorologists can have more interaction with NWS and participate in key forecast conference calls dealing with potential disastrous or large-scale weather events which will have a significant impact on the population.

The **medium-term action items/issues** (those which can be addressed in 4 years or less) included:

(1) Fund social science research for such activities as:

(a) Identifying urban stakeholder needs (stratified sample surveys of managers and general public).
(b) Testing messages and delivery systems (focus groups, simulations).
(c) Post-event assessments (fieldwork, surveys).
(d) Economic implications of forecasts.
(e) Understanding meteorological work culture (ethnographic studies of work environment).

(2) Investigate ways to share weather forecasts concerning potential disasters with the public media sooner, and (using the latest forecast data) allow interactions with NWS and government agencies (e.g., emergency managers) during the coordination of required actions.

There were no **long-term action items/issues** (those which can be addressed in 4 – 10 years) identified by workshop participants.

A complete summary of the Forum, as well as available presentations from this workshop, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum
Workshop 2A Summary

Workshop Name: Measurement Strategies for the Urban Weather and Climate Domains (sensors, data collection, transmission, archiving, etc.)

Workshop Cochairs: (1) Mr. Richard Fry, DOD/DTRA; and Dr. Sharon LeDuc, DOC/NOAA/NESDIS

Rapporteurs: Mr. Rickey Petty, DOE/Climate Change Result Division; and (2) Mr. Tony Ramirez, OFCM/STC

Guiding Questions

The questions poised below for this workshop were intended as guidance for focusing the workshop discussion.

(1) How should an observing network be designed to meet the requirements for meteorological and climate data in the urban environment? Which measurement tools, procedures, and processes are needed?

(2) What current programs (e.g., observational test beds, space-based systems) are addressing or planning to address observing network requirements?

(3) Which measurement strategies will provide the most efficiencies and best cost/benefit returns for operational decision makers?

(4) What needs are to be addressed across the spectrum of data gathering, collection, assimilation, archival, and dissemination processes?

(5) Are different observing networks needed for weather and climate domains in the near, mid, and far terms?

Synopsis

Opening Remarks

Dr. Leduc and Mr. Fry opened the workshop by reviewing the guiding questions and discussing the focus areas to be addressed during the workshop. Dr. Leduc discussed the initiatives within the meteorological community toward developing and implementing test beds in urban areas. She pointed out that these test beds should not only be deployed within the boundaries of urban areas but should also be placed in areas downwind to measure emissions from cities. She further stated that archived data is a current and growing need in the community.

Mr. Robert Banta, NOAA Environmental Technical Library, provided a short presentation on "Urban Projects." He discussed the use of Lidar in vertical and horizontal measurements by aircraft of airborne ozone. These measurements provide a capability to resolve the airborne distribution of matter in high resolution and provide a means of measurement for model verification. He further stated that data sets exist and are available from modeling experiments which use surface measurements and aircraft measurements with tracers to provide a controlled release of emissions.

Group Discussion

A wide-ranging discussion on "Measurement Strategies for the Urban Weather and Climate Domains" resulted in the following major findings:

(1) In an attack scenario, one of the immediate challenges facing first responders is determining the originating location or source of the agent being emitted. It may be feasible to "run the model in reverse" to serve in this purpose.

(2) Although ground-based Lidar exists, airborne Lidar provides much needed mobility. Ideally, for a given urban environment, an array of ground-based Lidars covering the extent of the urban area would be most useful.

(3) DHS and DTRA have funded a program to improve the diffusion network in New York City. This network uses tracer procedures for test and verification. This network is designed to be a long-term, highly reliable network with the capability of reporting in approximately 15-minute intervals.

(4) The sheer amount of data being generated by urban networks is likely to flood the existing databases and saturate the capability of existing communications infrastructure. The integrated surface observation (which includes ASOS, COOP, and climate reference network observations) increases the need for quality metadata, improved communications, and backup capabilities for both receipt and dissemination. Although bandwidth seems to be keeping up with today's volume, these capacities will also require expansion.

(5) State departments of transportation provide a source of road weather data. These data should be included in urban weather databases. The NOAA/Forecast Systems Laboratory ingests and archives road weather observation data. It is a significant part of its database that can be leveraged for urban applications.

(6) There is a need for separate weather sensors and climate sensors. The current and foreseeable budget climates will drive the need for multipurpose sensors (that can serve both weather and climate applications) rather than separate sensors. There appear to be sufficient similarities between both types of sensors.

(7) Strategies for cost effective measurements of weather parameters to meet the needs of operational decision makers should be based first on initiatives that are immediately affordable and achievable (low-hanging fruit). They should also be based on the

minimum amount of weather data and information needed by decision makers. A process is needed to determine the number of sensors needed at minimum cost, and should be applied to meet the unique complexity of each urban terrain. The specific needs will likely differ between different cities.

(8) First responders have a critical need for awareness of and access to the information and products that are available right now. There is a belief, however, that new technologies, products, and capabilities are not being used by first responders because they are not aware them. This indicates a need for better outreach, education, and training programs for users. To the first responder community, knowledge of and access to new products and support mechanisms is much more important than those in research and development. Rapid prototyping of new support mechanisms will be much more useful than those undergoing long periods of development, implementation, and validation. For information that is currently being used by first responders, improved communications and delivery mechanisms are a continued need.

(9) The first responders are only one part of the broad spectrum of users in the urban environment. Communications between users and providers must improve in order to ensure that the critical needs of the users are being met. The use of available data sources like GIS should be incorporated into the support mechanisms of every city. GIS-based support systems can be layered to meet the differing resolution needs of users. Federal agencies do not have a delivery system for this type of information for all users in the public domain or the commercial sector. A change in federal policy may be needed to allow these communications to be authorized.

(10) With regard to measurement strategies, the need to define a measurement system design process was proposed as the first step. This process should include steps on determining how to address particular applications, listing of each problem, designing implementation plans, and determining overlaps. A recently published U.S. Weather Research Program report outlines urban challenges and offers ideas on the design of networks on an urban scale. A review of this report should be a first step for action groups formed as the result of this forum.

Consensus Reached

The workshop resulted in the following areas of general agreement:

(1) Strategies for the cost effective collection of weather and climate measurement data for decision makers should first focus on things that can be accomplished immediately.

(2) A comprehensive process is needed to determine the amount and type of data needed and the number of sensors required for urban networks based on both standard and unique applications. This process must ensure that cost is minimized and should account for the complexity of terrain unique to every city.

(3) Users aren't aware of and therefore are not using emergency decision-making technologies and information that are available today. Outreach, education, and training mechanisms are needed.

(4) A delivery system is needed for layered GIS information to all public and commercial sectors. This may require a change in federal policy to authorize the communication of this information to these sectors.

(5) The process for defining how to design a network on an urban scale should address particular decision-making applications (e.g., define questions for applications and interact with users).

Unresolved Issues

There were no issues articulated during this workshop that seemed to end without coming to a general consensus on how the community might move forward to solve the issues presented.

Recommendations

Several key action items/issues were developed by the workshop participants.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Develop and implement test beds for urban areas.

(2) Explore the inclusion of road weather data for urban applications.

(3) Develop outreach, education, and training programs to meet the immediate needs of users.

(4) Develop a strategy for cost effective collection of data focusing on things that can be done now. Include the private sector role (including METADATA), products, and distribution

The **medium-long term action items/issues** (those which can be addressed in 4 years to 10 years) included:

(1) Ensure communications infrastructures are capable of accommodating the increasing amount of data and that formats are usable.

(2) Define a process on how to design a network on an urban scale and how to address particular decision-making applications.

There were no **long-term action items/issues** (those which can be addressed in 4 – 10 years) identified by participants in this workshop.

A complete summary of the Forum, as well as available presentations from this workshop, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum

Workshop 2B Summary

Workshop Name: Research and Development Needs for Ecosystem Approaches to Urban Health and Environmental Issues

Workshop Cochairs: (1) Dr. Robert Bornstein, San Jose State University and (2) Dr. John R. Scala, Millersville University

Rapporteurs: (1) Mr. Robert Dumont, DOC/NOAA/OFCM; and (2) Dr. Robert Katt, OFCM/STC

Guiding Questions

The questions posed below for the workshop were intended as guidance for focusing the workshop discussion.

(1) What visualization techniques are available or emerging that would help convey air/water quality and health hazard information to a variety of users?

(2) What new predictive initiatives address air quality forecasts and related health issues?

(3) What observational databases are needed for air/water quality modeling?

(4) What means are available to quantify and communicate air quality forecasts to decision makers?

(5) What evaluation and verification metrics are available or should be developed for air/water quality forecasts?

(6) What research tools can be used to measure socioeconomic impacts of wildfires and other regional severe atmospheric events on urban communities, as well as on the regional ecosystem?

Synopsis

Opening Remarks

The workshop cochairs welcomed the workshop participants and gave a general overview of the workshop's purpose which was to discuss and identify the research and development that is needed to support an ecosystem approach to health and other environmental issues in the urban community. Ideally, this approach should be part of an

integrated conceptual and strategic plan designed to minimize the effects of accidents, natural hazards, and terrorism-related events.

Group Discussion

The principal focus areas of the workshop were observations/instrumentation, data management, data assimilation and modeling, and the customer/user interface. Dr. Scala suggested three objectives which would address information gathering in the urban environment:

(1) We must acquire the necessary information in real time.

(2) We should utilize that information to address the customer's desire to know what may happen next.

(3) We must manage and analyze the information effectively so that we can determine the long-term impacts on the urban environment.

A wide-ranging discussion on "Research and Development Needs for Ecosystem Approaches to Urban Health and Environmental Issues" resulted in the following major findings with respect to observations/instrumentation, data management, data assimilation and modeling, and the customer/user interface:

(1) Observations/Instrumentation.

(a) Observations of the urban environment must be:

- Multi-scale networks with specific temporal and spatial resolution (e.g., fixed surface: mesoscale (centers at a few km), urban, neighborhood, roadway sensors, and observations updated every 15 minutes).
- Mobile: canyon-scale, few meters, real time.

(b) Instrumentation networks in the urban environment must be designed to address unique microclimates of the urban zone. Models (wind tunnel and numerical) should be designed to address specific fine-scale network attributes for a number of test cities.

(c) Assessment of the PBL is essential. Methods for assessing the PBL include LIDAR, radar, SODAR, and ceilometer.

(d) PBL assessment parameters should include: wind, temperature, PBL height (at least for test cities), surface and subsurface (ground/water) temperatures, precipitation, trace concentrations (gases and aerosols), vertical measurements with a resolution to 30 m, soil moisture, and fluxes (radiation, heat, momentum, and moisture).

(e) There are societal/community issues which must be considered, regarding network design and sensor placement to avoid, if possible, similar public response that developed during the proposed installation of the WSR-88D network.

(2) Data Management.

(a) Effective management of the data and information archive developed for the urban environment will be instrumental in addressing urban health and environmental issues. Key issues which the workshop participants identified included:

- The need for a national center to collect and manage the information. Perhaps the National Climatic Data Center (NCDC) could act as a repository.
- An interagency committee should be formed to oversee the design and management of the database system. It is essential that the database system be easily accessible. The system should be frequently updated; include "lots of metadata" accompanied by sufficient documentation (and be compatible with GIS); have standardized formats containing time, location, a naming convention; have XML as an option; and should consider the possibility of newer data methods. The database system should incorporate such concepts as data quality assurance/quality control vs. real-time data. The system should be open source and include societal data (e.g., demographic, economic, and diurnal/weekly patterns (?)) and ecological data. It should also incorporate a multi-source, multi-type data integration method.

(3) Data Assimilation and Modeling.

(a) To evaluate the environmental impacts on urban ecosystems, we must effectively assimilate the information gathered into the applicable modeling frameworks. The data assimilation issues discussed included the following:

- Assimilation of four-dimensional (4-D) lateral and upper boundary conditions are critical, and may be of more value than within urban measurements to initialize high resolution urban modeling efforts.
- Assimilation schemes to be considered include 3D-VAR, 4D-VAR, FDDA, NCAR methods, and FAA methods.
- The optimal interpolation scheme is old but cheap/fast. NCEP methods deserve consideration.
- There is a need to be able to assimilate remotely sensed surface, building, and aerosol data obtained on an irregular horizontal and vertical grid.

(b) Modeling considerations discussed included:

- Coupling of atmospheric transport and diffusion (ATD) model output with consequence models (e.g., health/safety impacts and others).
- Source location to support such activities as forensic modeling and contaminant identification (preferably by remote-sensing method).

- Model verification and certification based on user metrics (e.g., model performance under varying conditions and for varying averaging times and model post-processing and visualization to address end-user requirements).

(4) Customer/User Interface.

(a) In addressing urban health and environmental issues, it is critical that the customer/user be involved in the process. We need to identify the customer and:

- Find out what they want and how they intend to use the information provided.
- Use prototyping and develop products in an iterative manner.
- Educate users on the constraints (limitations) inherit in the products we provide them, and how to interpret the information to ensure appropriate application of the results.
- Communicate with users in a secure, reliable, robust, and fast manner.
- Develop effective product formats (graphical/text/tabular) and provide for multiple format delivery capability. That is, we need to tailor as needed for the emergency response center vs. customers in the field. Tailoring necessitates reliable communication practices. We also need multiple language capability.
- Ensure that data be displayed within the emergency management system so that it is not confusing to the user, thus emphasizing again the appropriate use by the customer.

(b) The bottom line is that users must have confidence in the results!

<u>Consensus Reached</u>

The workshop resulted in the following areas of general agreement:

(1) There is a need for improved multi-scale observations in the urban environment with an emphasis on the vertical observation of the PBL in greater detail.

(2) There is a need to establish a national database management center that facilitates data access and includes self-documenting metadata in standardized formats.

(3) There is a need to enable the integration of all data types and sources within an ecological framework (i.e., social, demographic, economic, etc.)

(4) There is a need to assimilate remotely sensed surface/building, boundary layer, and aerosol data into atmospheric transport and diffusion and other fine-scale models.

(5) There is a need to couple atmospheric transport and diffusion model outputs with consequence models, addressing health, safety, and other impacts.

(6) There is a need to develop model verification and validation procedures based on user metrics.

(7) The interface with users must be addressed in a more comprehensive and mutually supportive manner. It is necessary to find out what users want, how they want this information communicated, and how they operate. It is especially critical to get customer feedback during the product development/prototyping process. Greater outreach initiatives, end-to-end support, and identification of essential deliverables are needed.

Unresolved Issues

Issues that were articulated but could not be resolved during the panel session included:

(1) The optimal mix of instrument platforms and the temporal and spatial resolution of the required observations to foster a coordinated scientific design. The answer to the optimal mix question requires additional research, development, and testing.

(2) Urban test cities or test beds. The idea of these test sites needs to be further explored within the context of addressing urban health and environmental issues.

(3) Data management issues and the delivery of uncertainty information. These issues require extensive study.

Recommendation

Several key action items/issues were developed by the workshop participants.

The **short-term action item/issue** (those which can be addressed within the next year) included:

(1) The Office of the Federal Coordinator for Meteorological Services and Supporting Research should work within the Federal meteorological community and its coordinating infrastructure to establish an interagency committee on urban meteorology to address the consensus needs and unresolved issues identified during the course of this workshop and throughout the Forum.

The **medium-term action items/issues** (those which can be addressed within 4 years) included:

(1) Perform a study to determine the optimal mix of observations for the urban environment.

(2) Investigate the need for urban test cities or test beds (if we are to address the user needs of the urban environment).

(3) Address the issues of data management and the delivery of uncertainty information to the end user.

There were no **long-term action items/issues** (those which can be addressed in 4 – 10 years) identified by participants in this workshop.

A complete summary of the Forum, as well as available presentations from this workshop, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum
Workshop 3A Summary

Workshop Name: Communicating Hazardous Weather Risks in the Urban Environment

Workshop Cochairs: (1) Dr. David Krantz, Columbia University, (2) Ms. Sandy Thomson, WANE-TV, Fort Wayne, IN

Rapporteurs: (1) Mr. Frank Estis, OFCM/STC (2) Col Mark Weadon, DOD/USAF/Air Force Weather Deputy for Federal Programs (NOAA)

Guiding Questions

The questions posed below for this workshop were intended as guidance for focusing the workshop discussion.

(1) What methods are needed to better communicate and disseminate meteorological information, particularly for impending hazards in the five focus areas?

(2) Where should research and development be focused to further improve the communication of risks in the five focus areas?

(3) What are examples of successful risk communication about hazards in the five focus areas that can be used as models? For example, can NOAA Weather Radio be expanded/modified to meet the needs of urban communities?

(4) What new or emerging technologies will help communicate risks in the five focus areas more effectively to the urban community?

(5) How can education, outreach, and training be more effective in eliciting rapid and appropriate public response to imminent hazards in the five focus areas?

Synopsis

Opening Remarks

Ms. Sandy Thomson opened the workshop by emphasizing that the workshop guiding questions and the attendees' inputs were the key components to a successful workshop. She also highlighted some key statistics from the Urban Meteorology handout book to illustrate why it is important to focus on this topic now.

Dr. David Krantz highlighted the fact that his research shows that it is easier to communicate probabilities of an event occurring when the event means something to the people that are expected to react to the event. The audience must understand what action

is required of them so they can decide if the probability of occurrence is important to them, versus the cost of action or no action.

Group Discussion

A wide-ranging discussion on "Communicating Hazardous Weather Risks in the Urban Environment" resulted in the following major findings:

(1) There is a need to make sure potential disaster information gets to the media, police, fire personnel, and all other First Responders quickly so it can be relayed to public.

(2) Any system to be used to communicate risk needs to be simple, clear, standard, and easy to relay to public.

(3) The elderly and other at-risk groups need to be targeted for support to ensure they receive disaster notification information.

(4) There is a need to identify the types of natural hazard information the public needs/wants, such as, incidence of hazard risks in the area of interest; text or graphic messages, types of communication media to be used, etc.

(5) The utility of maps is limited if users cannot locate their position relative to weather features. General lack of geographical literacy among the public must be considered when conveying risk via maps.

Consensus Reached

The workshop resulted in the following areas of general agreement:

(1) Standard ways and terminology to communicate risk are needed. We cannot have regional variations in the way weather risk is communicated to the public. A national standard is essential.

(2) To account for a transient society, research is needed to determine terms to use on a national basis to communicate risk.

(3) The public is very mobile. There needs to be some kind of GIS/GPS communication system to reach people even when in transit.

(4) One example of successfully using technology is the linking of on-air broadcast meteorology shows to more in-depth information on web sites. TV audiences can get more detailed and updated information continually via the web. But, all severe weather risk should be communicated completely through radio or television media, as many in the public do not have computers or NOAA Weather Radio.

(5) Some sort of "categorization" or "risk-possibility" scale needs to be developed for all severe weather areas, and should be the same "standard" for all weather events (i.e., color-coding, numerical scale, letter-coding, etc.), so that the public will always know the risk factor or degree of severity. This scale should be teamed with an action, (e.g., what to do or where to go for each category). Once this standardization or nationalization is decided, the general public needs to be educated.

(6) There is a greater need for management in all five focus areas (i.e., Severe Weather, Homeland Security, Air Quality, Water Quality, and Climate) to work together toward these goals, thereby avoiding confusion for the public.

Unresolved Issues

There were no issues articulated during the workshop that seemed to end without coming to a general consensus on how the community might move forward to solve the issues presented.

Recommendations

Several key action items/issues were developed by the workshop participants.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Research ways to reach elderly and other at risk groups, making sure to include social science involvement to identify stakeholder needs (e.g., stratified sample surveys of managers and general public) and test messages and delivery systems (e.g., focus groups, simulations, etc.).

(2) Research terms to use to express risk to the public in a standard way, making sure to include social science involvement to identify stakeholder needs (e.g., stratified sample surveys of managers and general public) and test messages and delivery systems (e.g., focus groups, simulations, etc.)

(3) Investigate using Homeland Security color code system for the weather warning system, and/or look at a numerical or alphabetical categorization that would be consistent with each event, and specifically, something common or already familiar to people (i.e., red means stop…take shelter; yellow means yield…exercise caution, etc.) A "scale" should help the public understand their risk factor and percentage probabilities of being affected by the event.

(4) Investigate some kind of GIS/GPS communication system to reach people even when in transit.

(5) Look into developing a matrix approach to communicating risk. Use probabilities to express degree of risk for each type of weather event and actions required at each level of probable occurrence.

The **medium-term action items/issues** (those which can be addressed in 4 years or less) included:

(1) Develop an education program to engage hotels and other tourist industry groups, as well as school systems in getting the word out to the public on potential disaster events.

(2) Develop an education program for K-12 students on a warning system and terms used so they will grow up alert to the potential threats. Work with educational systems on a national basis to make sure it is a standard national program.

(3) Develop an education program for broadcast meteorologists on how to present weather and its risks to the public using different media and make sure social science is involved under the auspices of the AMS certification program and the NWA seal certification program. Work with broadcasters and weather equipment vendors to help establish a common color coding for watch/warning maps, etc.

(4) Determine stakeholder needs (e.g., stratified sample surveys of managers and general public) and test messages and delivery systems (e.g., focus groups, simulations, etc.)

(5) Seek NOAA's support to undertake a study on how to communicate weather risks (including uncertainty) to the general public. The study needs to include the expertise of sociologists and cognitive psychologists.

(6) Solicit user feedback on the clarity and comprehensibility of current modes of communicating weather risk.

There were no **long-term action items/issues** (those which can be addressed in 4 – 10 years) identified by participants in this workshop.

A complete summary of the Forum, as well as available presentations from this workshop, can be found on the OFCM web site: www.ofcm.gov.

Urban Meteorology Forum
Workshop 3B Summary

Workshop Name: Research and Development Resources to Address Deficiencies in Modeling for Urban Weather, Atmospheric Transport and Dispersion, Space Weather, and Climate Applications

Workshop Co-Chairs: (1) CDR Stephanie Hamilton, DOD/USN/DTRA and (2) Dr. Steven Hanna, Harvard School of Public Health

Rapporteurs: (1) Dr. Robert Katt, OFCM/STC and (2) Mr. Jim McNitt, OFCM/STC

Guiding Questions

The following questions were presented to the workshop participants to help guide the discussion:

(1) What current or emerging science and technology resources are available to mitigate deficiencies in urban meteorological, atmospheric transport and dispersion and climate modeling? Are the funding resources for these existing efforts adequate?

(2) Are mechanisms available to transfer and apply emerging science and technology to address deficiencies in urban weather, atmospheric transport and dispersion, and climate modeling? If mechanisms are available, are they funded adequately to meet user requirements for modeling products?

(3) Are processes established to ensure the effective transfer of better modeling products to users' operations? What role should users play in the development and transfer process to ensure products are useful?

(4) What type of basic or applied research and development is needed to meet deficiencies or future needs/challenges in urban weather, ATD, and climate modeling?

(5) What criteria should be used to assign priorities for future research and development that addresses urban weather, atmospheric transport and dispersion, and climate modeling?

(6) How could collaborative research and development efforts be improved?

Synopsis

Opening Remarks

The purpose of the workshop was to discuss the research and development resources that are both available and required to address deficiencies in modeling for urban weather, atmospheric transport and dispersion, and climate applications. The co-chairs reviewed the guiding questions by providing several discussion topics for each question. The resulting discussion highlighted problems and in some cases, potential solutions, to the following problems/issues:

(1) Recent and current field studies and data bases.

(2) Test beds (long-term observing sites).

(3) Current modeling efforts and scientific problems.

(4) Data needs for model inputs and evaluations.

(5) Standards and guidelines for models and for data collection.

(6) R&D needs for urban weather, ATD and climate.

(7) Transfer from research to operations.

(8) Collaborations.

(9) Interface with users.

Group Discussion

A wide-ranging discussion on "Research and Development Resources to Address Deficiencies in Modeling for Urban Weather, Atmospheric Transport and Dispersion, and Climate Applications" resulted in the following major findings:

(1) There is a need to collect, process, and synthesize data from existing field studies such as:

(a) Recent and current urban studies (e.g. Joint Urban 2003, NYC Urban Dispersion Program, DCNet).
(b) Fluid modeling (wind tunnels and water flumes).
(c) NSF urban climate and surface energy studies.

(2) There is a need to investigate urban data sets that are being developed by cities, government agencies, and others and add them to existing data bases being used to develop, calibrate, and evaluate urban models. Possibly additional parameters could be measured and procedures improved for their use as inputs to models.

(3) Data for fine-scale model development and evaluation, e.g., Computational Fluid Dynamics (CFD) model parameter calibration are needed. Involving a range of modelers and researchers when designing databases, for both current data analysis projects and for future data collection efforts is needed. The types of data needed include urban canopy/land cover/morphology, surface fluxes, soil moisture, ocean in coastal areas, water use, population, anthropogenic contributions, etc.

(4) Physical modeling facilities, such as wind tunnels are resources for urban modeling. They are important for improvements in knowledge of urban canopy atmospheric transport and dispersion.

(5) There is a need for establishing standards and guidelines for databases, model output, and model performance and acceptance criteria.

(6) Users' needs should be considered in prioritizing R&D needs.

(7) The transfer from research to operations should be user-based and include collaboration during all phases of the system life-cycle. Users should be included early and often. Involve social scientists and other related disciplines in the user interface. Recognize and account for differences in user communities.

(8) Collaborative studies are needed, but should include: leveraging of planned experiments, a clearinghouse for information, and better communications among user communities.

(9) For urban climate modeling, there is a need for a consistent way (e.g., test beds) to compare and evaluate model results.

(10) U.S. Weather Research Program (USWRP) Prospectus Development Team (PDT)-10 is a resource for modeling requirements in a wide range of topics that fall under urban meteorology, such as urban wildfires and enhancement to precipitation. USWRP PDT-11 is a resource for modeling requirements for air quality.

(11) For some needs such as first response to a CB release, a modeling capability is needed that allows immediate (i.e., within 1 or 2 minutes) response.

(12) Urban test beds need to be set up at all scales (street canyon to metropolitan), and should deal with interactions between urban areas and their surroundings.

(13) There is a need to foster collaborative work starting with federal agencies extending to strategic partnerships with local and state government agencies, the private sector, and universities.

Consensus Reached

The workshop presentations and the attendant discussion resulted in the following areas of general agreement:

(1) There is a need to collect, process, and synthesize data from existing field studies. New data sets for better understanding of urban meteorological and ATD processes and for model development are needed. There is a need for more continuous data records (urban meteorological and atmospheric transport and dispersion conditions over longer periods of time, such as test beds would provide).

(2) There is a need to investigate urban data sets which are being developed by cities, government agencies, and others. These data sets should be added to existing data bases being used to develop, calibrate, and evaluate urban models. Possibly additional parameters could be measured and procedures improved for their use as inputs to models.

(3) Collaboration and more effective communications are required in many of the ongoing urban R&D activities. Effective collaboration can lead to partnerships, leveraging of planned experiments, and better communication. Collaboration should include the integration of the end-users' feedback in every phase of a system's life-cycle. Social scientists should be involved to facilitate the interface between the developer, information provider, and end-users of the information (e.g., decision-makers and public). There is a need to foster collaborative work starting with federal agencies extending to strategic partnerships with local and state government agencies, the private sector, and universities.

(4) Urban test beds need to be set up at all scales (i.e., street canyon to metropolitan), and should deal with interactions between urban areas and their surroundings. Urban test beds should account for the effects of the ocean on the coastal urban areas. For urban climate modeling, the test bed can lead to a consistent way to compare and evaluate model results.

Unresolved Issues

Issues that were articulated but could not be resolved during the panel session included:

(1) The best way to assimilate meteorological observations in urban areas into high-resolution mesoscale meteorological models.

(2) Best approach to collect, process, and synthesize data from existing field studies.

(3) Best approach for test beds.

(4) Approach to implementing a national database for land cover/morphology data.

(5) How to establish standards and guidelines for databases, model output, and model performance and acceptance criteria. Standards Developing Organizations are preferred for some standards, such as for model performance (e.g., the ASTM currently has available a document describing standards for dispersion model evaluation).

(6) How to incorporate the multi-tiered modeling response required to provide increasingly sophisticated hazards predictions as more information about the source becomes available and more sophisticated meteorological inputs can be provided for use with the ATD code. Emergency responders at the workshop stated the need for a modeling capability that allows immediate (i.e., within 1 or 2 minutes) response.

(7) Approach for prioritizing research needs. How to set priorities. What are the prioritization factors?

(8) Basic research challenges. Basic research is required to improve surface fluxes, and to improve data assimilation methods.

(9) The urban meteorology community should be able to contribute to city planning, to address critical trade-offs and design issues (implications of vegetation on hydrology and water use).

(10) Future research is expected to involve more emphasis on sensor fusion, where observations of urban pollutant concentrations and meteorological variables are used to back-calculate the expected location and magnitude of the source (e.g., for CB releases by terrorists).

Recommendations

Several key action items/issues were developed by the workshop participants.

The **short-term action items/issues** (those which can be addressed within the next year) included:

(1) Establish a science advisory group (representative of segments within the user community).

(2) List field and fluid modeling studies and experiments that have been done with points of contacts.

(3) Find out who is building urban databases.

(4) Identify user communities and facilitate communications among researchers and modelers, decision-makers, and the public.

(5) Improve mesoscale models and CFD models and establish links (e.g., two-way feedback) where possible.

The **medium-term action items/issues** (those which can be addressed in 4 years or less) included:

(1) Establish a clearinghouse (so that everyone can know what is available) for planned urban studies and data collection efforts.

(2) Start Federal interagency collaboration to plan a national, federated urban canopy/land cover/morphology database. Investigate work being done in the various Federal interagency working groups.

(3) Investigate existing urban meteorological, atmospheric transport and dispersion, and climate data sets and their applicability to current research.

(4) Develop urban parameterizations for mesoscale meteorological models and CFD models.

(5) Improve data assimilation and sensor fusion methods.

The **long-term action items/issues** (those which can be addressed in 4 – 10 years) included:

(1) Capture existing data needs and data synthesis required, such as the need to develop urban parameterizations for inputs to CFD and mesoscale models.

(2) Prioritize field and fluid modeling studies and experiments that should done, as well as longer-term test beds.

(3) Implement an accessible, distributed national data system for use in urban modeling

(4) Develop methods to integrate data in high-resolution models working at the micro-scale, including both current data and future data (point and volumetric). A range of modelers and researchers need to be involved to identify future data requirements.

(5) Improve research transfer to operations, emphasizing user-based needs.

(6) Plan field studies of urban parameters for use in fundamental models. These would include surface fluxes and turbulence profiles.

(7) Sustain urban test bed operations over a sufficient time to characterize model and instrument performance across the full range of weather variations.

(8) Further develop cross-discipline studies where urban meteorology is a component, such as urban design and planning, and risk-consequence studies.

A complete summary of the Forum, as well as available presentations from this workshop, can be found on the OFCM web site: www.ofcm.gov.

Dr. Elbert W. (Joe) Friday, WeatherNews Professor of Meteorology and Founding Director of Sasaki Applied Meteorology Research Institute
University of Oklahoma

and

Dr. Paul D. Try, Senior Vice President
Science and Technology Corporation

Forum Outcomes

Dr. Elbert Friday and Dr. Paul Try presented the outcomes from the Forum. They started by providing the salient points from Dr. James Mahoney's presentation on a system solution. To optimize that solution, Drs. Friday and Try reminded the Forum participants that the objective of such a system is to minimize adverse effects of accidents and terrorism events. The constraints to meeting that objective are irreducible uncertainties such as meteorological dispersion parameters and hazardous materials releases.

The presenters reiterated the Forum participants' finding that urban meteorology is a complex issue requiring a consistent message. That message should, for example, simplify the message to funding agencies and should start by defining "urban meteorology." The message should focus on an end-to-end system, emphasize societal impacts (in terms of cost/benefit), improve collaboration, facilitate partnerships, and foster the development of an integrated/coordinated program (plan).

Drs. Friday and Try noted that the Forum participants identified many issues within urban meteorology. These issues run the gamut from data, databases, instruments, siting, four-dimensional data assimilation, model, communications, formats, to applications. However, they stressed that these issues are tractable and manageable with focus and coordinated planning. A coordinated plan would address policy issues/questions and information and data needs attributes. The policy issues/questions might include:

(1) Who is in charge and what are the agency responsibilities?

(2) How much do you tell the public?

(3) What incentives are there for good behavior?

A coordinated plan would address such information and data needs attributes as being consistent, reliable, user-centric, and preloaded. Other considerations within a coordinated plan would include communications issues (e.g., science coordination mechanisms, user/producer linkage, and the appropriate amount of information) as well as an ecosystem approach (e.g., humans are a part of the ecosystem and the ecosystem is dynamic).

An urban meteorology observation strategy was the focus of several workshops and panel presentations. Drs. Friday and Try summarized that the strategy would embrace (among other things) adding instruments for urban perimeter surface/boundary layer boundary conditions coupled to broader synoptic/mesoscale flow, utilizing existing urban network data, facilitating a national urban morphological database, and establishing high resolution demonstration/test bed projects for user feedback.

The presenters ended by asserting that greater collaboration, strategic planning, and outreach should facilitate the development of an improved end-to-end urban meteorological support system.

A complete summary of the Forum, as well as the remarks from Drs. Friday and Try, can be found on the OFCM web site: www.ofcm.gov.

Ms. Margaret McCalla, Senior Staff Meteorologist
Office of the Federal Coordinator for Meteorological Services and Supporting Research

Next Steps

Ms. McCalla presented the near-term next steps which OFCM proposed as a result of the Forum. The near-term steps are those that can be addressed in 1 year or less.

Actions which OFCM will take in the first week after the Forum include:

(1) Producing a forum summary.

(2) Posting forum summary and presentations on the OFCM website.

Actions which OFCM will take in the next 3 to 4 months include:

(3) Finalizing the forum proceedings.

(4) Posting the forum proceedings on the OFCM website.

Actions which OFCM will propose taking 30 days after the Forum include:

(5) Forming an Interagency Working Group to develop and coordinate a **Plan of Action** to build a framework which will address the following cross-cutting issues and identify organizational responsibilities:

(a) Regional ecosystems planning and management.
(b) Urban observations.
(c) Research and technology.
(d) Urban modeling.
(e) Information dissemination.
(f) Education, outreach, and training.
(g) Support for business continuity.

(6) Forming Joint Action Groups during the course of the year to work specific cross-cutting issues and invite outside participation from private and academic sectors.

A summary of the Forum, as well as Ms. McCalla's remarks, can be found on the OFCM web site: www.ofcm.gov.

Mr. Samuel P. Williamson, Federal Coordinator
Office of the Federal Coordinator for Meteorological Services and Supporting Research

Closing Remarks

The Federal Coordinator began the session by thanking everyone for making the Forum a success. He also acknowledged and thanked the Department of Homeland Security, Science and Technology Directorate for its partnership in developing the Forum. He noted that more than 120 people attended the Forum and that the participants represented the many sectors of the community, including both providers and users of urban zone information. He also stated that during the Forum progress was made in putting key issues on the table that will be useful in defining a framework for addressing atmospheric hazards, weather events, and climate issues associated with the urban zone.

Mr. Williamson stated that the Forum's executive summary and presentations will be available on the OFCM web site within two weeks after the Forum adjourns. Issues identified during the Forum will be captured in the Forum proceedings. The Forum proceedings should be available in 3 - 4 months. The overarching approach is to work the highest priority issues immediately. Therefore, the Federal Coordinator will inform the Federal Committee for Meteorological Services and Supporting Research (FCMSSR) about the high priority near-term strategic challenges. The highest priority strategic challenge is to develop a strategy for addressing issues associated with the urban zone. When the Federal Coordinator reports the results of this Forum to FCMSSR, he will seek its endorsement of a framework for pursuing how to address the urban zone issues.

Mr. Williamson adjourned the Forum and wished safe travels to all.

A summary of the Forum, as well as Mr. Williamson's remarks, can be found on the OFCM web site: www.ofcm.gov

APPENDIX A – LIST OF ACRONYMS

AAA – American Automobile Association
AC – Air Conditioning
AFWA – Air Force Weather Agency
AMS – American Meteorological Society
ASTM – American Society for Testing and Materials
ATD – Atmospheric Transport and Diffusion (Dispersion)
BWIC – Bio-Warning and Incident Characterization
CB – Chemical/Biological
CBM – Certified Broadcast Meteorologist
CDC – Centers for Disease Control and Prevention
CDR – Commander
CEO – Chief Executive Officer
CFD – Computational Fluid Dynamics
Col – Colonel
DCNet – District of Columbia Network
DHHS – U.S. Department of Health and Human Services
DHS – U.S. Department of Homeland Security
DOC – U.S. Department of Commerce
DOD – U.S. Department of Defense
DOE – U.S. Department of Energy
DOT – U.S. Department of Transportation
DTRA – Defense Threat Reduction Agency
EPA – Environmental Protection Agency
FAA – Federal Aviation Administration
FCMSSR - Federal Committee for Meteorological Services and Supporting Research
FDDA – Four-dimensional data assimilation
FEMA – Federal Emergency Management Agency
FNMOC – Fleet Numerical Meteorology and Oceanography Center
FY – Fiscal Year
GEM – Global Environmental Multi-scale (forecasting and modeling system)
GFDL – Geophysical Fluid Dynamics Laboratory
GIS – Geographic Information System
GPS – Global Positioning System
HPAC - Hazard Prediction and Assessment Capability
HVAC – Heating, Ventilation, and Air Conditioning
IBHS – Institute for Business and Home Safety
IBM – International Business Machines
IMAAC - Interagency Modeling and Atmospheric Assessment Center
IT – Information Technology
LETS – Local Exchange Trading System
LIDAR – Light Detection and Ranging
Lt Col – Lieutenant Colonel
mb – Millibar
MD - Maryland

NASA – National Aeronautics and Space Administration
NC – North Carolina
NCAR – National Center for Atmospheric Research
NCEP – National Centers for Environmental Prediction
NESDIS – National Environmental Satellite, Data, and Information Service
NGC – Northrop Grumman Corporation
NHC – National Hurricane Center
NOAA – National Oceanic and Atmospheric Administration
NOS – National Ocean Service
NSTC – National Science and Technology Council
NWP – Numerical weather prediction
NWS – National Weather Service
NYC – New York City
OAR – Office of Oceanic and Atmospheric Research
OFCM – Office of the Federal Coordinator for Meteorological Services and Supporting Research
OSTP – Office of Science and Technology Policy
PBL – Planetary Boundary Layer
PDT – Prospectus Development Team
QA – Quality assurance
QC – Quality control
R&D – Research and development
SODAR – Sound detection and ranging
STC – Science and Technology Corporation
TX – Texas
URL – Uniform Resource Locator
U.S. (US) – United States of America
USACE – U.S. Army Corps of Engineers
USAF – U.S. Air Force
USDA – U.S. Department of Agriculture
USOCOM – U.S. Ocean Commission
USWRP – U.S. Weather Research Program
WMO – World Meteorological Organization
WRF - Weather and Research Forecast System
WSR-88D – Weather Surveillance Radar – 1988 Doppler
XML – Extensible Markup Language
3-D Var – Three-dimensional variational analysis
4-D Var – Four-dimensional variational analysis

APPENDIX B - AGENDA

CHALLENGES IN URBAN METEOROLOGY: A FORUM FOR USERS AND PROVIDERS

September 21–23, 2004
Doubletree Hotel & Executive Meeting Center
1750 Rockville Pike
Rockville MD 20852

Theme: Information to Improve Community Responses to Urban Atmospheric Hazards, Weather Events, and Climate

Scope/Impact: Nearly two-thirds of the U.S. population lives in urban areas occupying less than two percent of the U.S. landmass. America's vulnerability to severe weather, homeland security incidents, and risks from air and water quality and climatic variations are rising as more of the population moves into areas prone to these hazards.

- $11 billion in damages per year occur from hurricanes, tornadoes, floods and other severe weather.
- Adverse weather adds to the cost of highway congestion, which now averages $78 billion a year in lost time and wasted fuel.
- Emergency response plans require real-time decisions about evacuations affecting thousands of households in a single incident.

To manage these and other risks to public safety, health, and property, urban leaders and managers need more accurate and specific weather information as input to their decision processes.

AGENDA

Tuesday, September 21

7:30–8:30 a.m.	**Continental Breakfast**
8:30–8:45 a.m.	**Mr. Samuel P. Williamson**, Federal Coordinator for Meteorological Services and Supporting Research *Opening Remarks*
8:45–9:05 a.m.	**Dr. Kathie Olsen**, Associate Director for Science, Office of Science and Technology Policy *Policy, Science, and Partnership Issues for the Complex Urban Environment*
9:05–9:20 a.m.	**Ms. Nancy Suski**, Director, Emergency Preparedness and Response Portfolio, Science and Technology Directorate, U.S. Department of Homeland Security *Homeland Security Needs in Urban Meteorology*
9:20–9:35 a.m.	**Mr. Eric Webster**, Majority Staff Director, House Science Subcommittee on Environment, Technology and Standards *A Congressional Perspective on Urban Meteorology*
9:35–9:50 a.m.	**Dr. Ronald D. McPherson**, Executive Director, American Meteorological Society *Perspectives on Interdisciplinary Scope and Approaches to Urban Meteorology*

Tuesday, September 21—continued

9:50–10:05 a.m.	**Dr. Gilbert Brunet,** A/Director, Meteorological Research, Meteorological Services of Canada *The Regional and Urban Numerical Weather Prediction and Operational Long Range Plan for the Meteorological Service of Canada*
10:05–10:35 a.m.	***Break***
10:35 a.m.–12:05 p.m.	**Panel 1:** Safety, Health, and Economic Impacts of Weather and Climate in the Urban Environment Panelists **Dr. John A. Dutton,** Professor Emeritus of Meteorology and Dean Emeritus College of Earth and Mineral Sciences, The Pennsylvania State University (*Co-moderator*) **Mr. Ray Ban**, Executive Vice President of Meteorology Science and Strategy, The Weather Channel (*Co-moderator*) **Dr. John Hayes**, NOAA/NWS **Dr. Josephine Malilay**, CDC **Mr. Richard Carbone**, NCAR **Dr. Sharon LeDuc**, NOAA/NESDIS/NCDC
12:05–1:30 p.m.	***Lunch***
1:30–3:00 p.m.	**Panel 2:** Regional Ecosystem Approaches to Urban Environmental Hazard Management Panelists **Dr. Douglas DeMaster**, NOAA/NMFS (*Co-moderator)* **Dr. Laurence S. Kalkstein**, Senior Research Fellow, Center for Climatic Research, University of Delaware (*Co-moderator)* **Mr. Leroy Spayd**, NOAA/NWS Meteorological Services Division **Mr. Allan Stahl,** Natural Resource Conservation Service/USDA **Dr. Eugene Stakhiv**, Institute for Water Resources/USACE **Dr. Sue Grimmond**, International Association for Urban Climate
3:00–3:30 p.m.	***Break***
3:30–5:00 p.m.	**Panel 3:** Adequacy of Urban Weather Observations Panelists **Dr. Rayford P. Hosker, Jr.**, NOAA/OAR (*Co-moderator*) **Dr. Ken Crawford**, Oklahoma State Climatologist (*Co-moderator*) **Dr. Walter Dabberdt**, Vaisala **Mr. Richard Fry**, DTRA **Dr. Jan Dutton**, AWS Weather Bug **Dr. John McGinley,** NOAA/Forecast Systems Laboratory
5:00–5:10 p.m.	Administrative Remarks — Ms. Erin McNamara, OFCM Conference Coordinator for Logistics
5:10 p.m.	***Adjourn Day 1 session*** OFCM Staff Meeting
5:30 p.m.	Icebreaker

Wednesday, September 22

7:00–8:00 a.m. **Continental Breakfast**

8:00–8:05 a.m. Administrative and Logistical Remarks — Ms. Erin McNamara, OFCM Conference Coordinator for Logistics

8:05–9:35 a.m. **Panel 4:** Research and Development for Urban Weather and Climate Applications

Panelists

Dr. Alexander MacDonald, Director, NOAA Forecast Systems Laboratory, (*Co-moderator*)
Dr. J. Marshall Shepherd, Research Meteorologist, Laboratory for Atmospheres, NASA-Goddard Space Flight Center (*Co-moderator)*
Dr. Robert Bornstein, San Jose State University
Dr. Lloyd A. Treinish, IBM Thomas J. Watson Research Center
Ms. Teresa Lustig, DHS, Science and Technology Directorate
Mr. David Williams, EPA/Office of Research and Development/ Environmental Sciences Division

9:35–10:05 a.m. ***Break***

10:05–11:35 a.m. **Panel 5:** Managing Risk in the Urban Environment

Panelists

Mr. Harvey Ryland, President and CEO, Institute for Business and Home Safety (*Co-moderator)*
Ms. Margaret Davidson, Director, NOAA Coastal Services Center *(Co-moderator)*
Mr. Ranger Dorn, Battalion Chief, Ventura Co. Fire Department
Mr. John Gambel, DHS/FEMA
Ms. Janet Anderson, USDA Forest Service/Fire and Aviation Management
Mr. Jim Cook, Emergency Manager, Atlanta, Georgia

11:35 –11:55 a.m. **Dr. Walter D. Bach, Jr.**, Program Manager, Environmental Sciences Division, Engineering Sciences Directorate, U.S. Army Research Office
Summary of the Report, "Federal Research and Development Needs and Priorities for Atmospheric Transport and Diffusion Modeling"

11:55 a.m.–1:05 p.m. **Luncheon Session with Dr. James R. Mahoney**, Assistant Secretary of Commerce for Oceans and Atmosphere and NOAA Deputy Administrator
Delivering Improved Weather and Climate Services for the Urban Zone

1:05–1:30 p.m. ***Transition to Workshop Sessions***

1:30–3:00 p.m. Concurrent Workshop Sessions 1A and 1B

Workshop Session 1A
How to Improve the Content of Weather Observations to Meet Modeling and Operational Needs for Urban Areas

Workshop co-chairs

Dr. Stephen Lord, NOAA/NCEP
Col. Mark Weadon, Air Force Weather Deputy for Federal Programs/ NOAA

Wednesday, September 22—continued

Workshop Session 1B
Understanding the Needs of Urban Communities and Businesses

Workshop co-chairs
Dr. Betty Hearn Morrow, Consultant and Professor of Sociology, Emeritus, Florida International University
Dr. Walter Maestri, Jefferson Parish, Louisiana Emergency Management

3:00–3:30 p.m. ***Break***

3:30–5:00 p.m. Concurrent Workshop Sessions 2A and 2B

Workshop Session 2A
Measurement Strategies for the Urban Weather and Climate Domains (sensors, data collection, transmission, archiving, etc.)

Workshop co-chairs
Mr. Richard Fry, Defense Threat Reduction Agency
Dr. Sharon LeDuc, Deputy Director, NOAA/NESDIS/NCDC

Workshop Session 2B
R&D Needs for Ecosystem Approaches to Urban Health and Environmental Issues

Workshop co-chairs
Dr. Douglas DeMaster, NOAA/NMFS
Dr. John R. Scala, Millersville University

5:00–5:10 p.m. Administrative Information Provided to Workshops — Ms. Erin McNamara, OFCM Conference Coordinator for Logistics

5:10 p.m. ***Adjourn Day 2 session***
OFCM Staff Meeting

Thursday, September 23

7:00–8:00 a.m. **Continental Breakfast**

8:00–9:30 a.m. Concurrent Workshop Sessions 3A and 3B

Workshop Session 3A
Communicating Hazardous Weather Risks in the Urban Environment

Workshop co-chairs
Dr. David Krantz, Columbia University
Ms. Sandy Thomson, WANE-TV, Fort Wayne, IN

Workshop Session 3B
R&D Resources to Address Deficiencies in Modeling for Urban Weather, ATD, Space Weather, and Climate Applications

Workshop co-chairs
CDR Stephanie Hamilton, USN, DTRA
Dr. Steve Hanna, Harvard School of Public Health

9:30–10:00 a.m. ***Break***

Thursday, September 23—continued

10:00–10:15 a.m.	**Mr. Dave Jones**, Founder, President & CEO, StormCenter Communications, Inc., and President, Foundation for Earth Science *Increasing the Environmental I.Q. of America through innovative agency and media partnerships*
10:15–10:30 a.m.	**Dr. Richard D. Rosen**, Assistant Administrator, Office of Oceanic and Atmospheric Research, NOAA *R&D to Meet Urban Weather and Climate Needs*
10:30–10:45 a.m.	**Ms. Chris Elfring**, Director, Board on Atmospheric Sciences and Climate, National Academy of Sciences *Challenges in Making Weather and Climate Information Useful in Decision Making*
10:45–11:00 a.m.	Summaries from Panel Moderators — Mr. Robert Dumont, OFCM
11:00–11:20 a.m.	Summaries from Workshop Co-Chairs — Lt. Col. Robert Rizza, OFCM
11:20 a.m.–12:00 p.m.	**Dr. Elbert W. (Joe) Friday**, WeatherNews Professor of Meteorology and Founding Director of the Sasaki Applied Meteorology Research Institute, University of Oklahoma **Dr. Paul D. Try,** Senior Vice President, Science and Technology Corporation *Forum Outcomes*
12:00–12:10 p.m.	**Ms. Margaret McCalla**, Senior Staff Meteorologist, OFCM *Next Steps*
12:10–12:25 p.m.	**Mr. Samuel P. Williamson**, Federal Coordinator for Meteorological Services and Supporting Research *Closing Comments and Forum Adjournment*

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APPENDIX D – PRESENTATIONS

Due to the volume of presentations and to take advantage of web technology, the presentations made during the Forum are available on the OFCM web site.

The URL is http://www.ofcm.gov.